



Study

# DESKTOP CAPACITY EVALUATION

## City of Kingston Wastewater Treatment Facility

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## EXECUTIVE SUMMARY

The City of Kingston (City) Wastewater Treatment Facility (WWTF) operates under New York State Pollution Discharge Elimination System (SPDES) Permit Number NY-002 9351. In response to several proposed residential and mixed use developments (Hudson Landing, Sailor's Cove and the Parking Garage Redevelopment projects), the City retained Malcolm Pirnie, Inc. to evaluate the capacity of the WWTF. The purpose of this study was to evaluate the capacity of the WWTF in relation to its ability to treat organic loads.

The evaluation of the WWTF was completed through the development of a BioWin model of the WWTF to simulate different loading conditions. Based on this model it has been determined that the WWTF has sufficient capacity to treat current and future loads with minor modifications. These modifications include changing the mode of operation from plug flow to either plug flow with a higher return activated sludge (RAS) rate or step feed operation in the future. Modifications would be necessary prior to Hudson Landing commencing its fifth phase of construction. By changing the mode of operation to either plug flow with increased RAS rate or step feed, the ultimate oxygen demand (UOD) of the effluent is significantly reduced.

The model projects an increase in the effluent UOD load to the receiving body of only 18 percent (%) in the step feed mode and 24% in the plug flow with higher RAS rate. In either mode of operation, the effluent UOD load is well below the SPDES permitted limit of 4,900 pounds per day (lbs/d). In fact, at average conditions, the model predicts that the WWTF effluent UOD load will only be at 70 percent or 76 percent of the SPDES limit with the step feed or plug flow with higher RAS rate modes of operation, respectively.

Changing the mode of operation from conventional plug flow to step feed or plug flow with higher RAS rate will require an increase in the mixed liquor suspended solids (MLSS) concentration of the aeration basins. The development of selector zones within the aeration basins, the addition of a 5<sup>th</sup> secondary clarifier to increase the hydraulic retention time and reduce the surface overflow rate, and/or the use of a polymer additive in the secondaries may also reduce the potential for solids washout due to wet weather flows. This type of operational strategy has been successfully utilized in other northeastern United States cities such as New York and Philadelphia.

Other suggested improvements to the WWTF include the installation of automatic gates in the aeration basins, and improvements to the blowers and control system to automate the operation of the aeration system and polymer system, if required.

# **1.0 Introduction**

## **1.1 Background Information**

The City of Kingston Wastewater Treatment Facility (WWTF) operates under the New York State Pollution Discharge Elimination System (SPDES) Permit Number NY 002 9351. The plant currently treats domestic wastewater from the City of Kingston and neighboring municipalities and is planning to accept sewage from three proposed mixed use developments (Hudson Landing, Sailor's Cove, and the Parking Garage Redevelopment). The WWTF, as it currently exists, was upgraded in the early 1970s to treat sewage using a conventional activated sludge process. During that time, the WWTF was designed for an average flow of 4.8 million gallons per day (mgd) through the aeration and secondary clarification processes. Modifications to the WWTF included the addition of a fourth primary clarifier in the early 1980s and the construction of a third aeration tank and a fourth secondary clarifier in the early 1990s. The current SPDES permit limits the average flow to 6.8 mgd on a 12-month rolling average. The plant effluent discharges to the Rondout Creek, a tributary to the Hudson River.

## **1.2 Purpose of Report**

The objective of this study is to evaluate the organic and solids loading capacity of the liquid stream of the WWTF and to assess the potential impacts of the three proposed developments on the capacity of the WWTF.

Malcolm Pirnie, Inc. (Malcolm Pirnie) has been retained by the City as an independent consultant to complete the evaluation and develop a BioWin model of the WWTF.

## **1.3 Scope of Work**

The scope of work for this study includes the following tasks to evaluate the organic and solids loading capacity of the WWTF:

- Evaluate current WWTF data to determine current flows and loads to the plant and projected flows and loads for the proposed developments.

- Develop a BioWin process model of the existing liquid stream of the WWTF based on the data provided to Malcolm Pirnie.
- Develop a simulation of the existing conditions to perform a desktop calibration of the process model, and a simulation of the future conditions including flows and loads from the proposed developments and flow commitments to neighboring communities.

The findings of this study are outlined herein and are supported by the information presented in the appendices attached to this Report.

## **1.4 Facility Description**

The liquid stream of the WWTF consists of the following unit processes:

- Screens
- Grit Removal
- Primary Clarifiers
- Aeration Basins
- Secondary Clarifiers
- Ultraviolet (UV) Disinfection

The sludge handling systems of the WWTF consist of the following unit processes:

- Dissolved Air Flotation (DAF)
- Gravity Thickening
- Belt Filter Press
- Anaerobic Digesters

Wastewater flows into the WWTF through the headworks (consisting of the screens and grit removal system) prior to entering the four primary clarifiers. The primary clarification effluent combines with return activated sludge (RAS) from the secondary clarifiers and is pumped to the aeration basins. Mixed liquor from the aeration basins flows by gravity to the secondary clarifiers for final settling. Secondary effluent flows by gravity to the UV disinfection system. The final effluent is discharged into the Rondout Creek, a New York State Department of Environmental Conservation (NYSDEC) Class C stream.

Sludge from the primary clarifiers is pumped to the gravity thickener. Waste activated sludge (WAS) from the secondary clarifiers is thickened in the DAF system. The combined sludge from the thickener and from the DAF is pumped to the anaerobic digesters. Digested sludge is dewatered in a belt filter press.

The overflow from the gravity thickener and a portion of the belt filter press filtrate are recycled back to the head of the primary settling tanks. The remaining portion of the belt filter press filtrate and the DAF supernatant are recycled back to the aeration tanks for treatment.

## 2.0 WWTF Operating Data Analysis

### 2.1 Effluent Requirements

Effluent limitations and monitoring requirements have been established by the NYSDEC as part of the SPDES permit program. A copy of the current SPDES permit (NY-0029351) is attached as Appendix A. The permit was last revised in September 2005. The final SPDES effluent limitations that impact the analysis of the aeration system are summarized in Table 2-1, below. The effluent limits of most significance with respect to the aeration system are the five-day carbonaceous biochemical oxygen demand (CBOD<sub>5</sub>) and the ultimate oxygen demand (UOD). The conditions of the SPDES permit do not require the WWTF to provide nitrification. However, the SPDES permit requires WWTF operational personnel to monitor the plant effluent for both Total Kjeldahl Nitrogen (TKN) and ammonia (as NH<sub>3</sub>). The TKN is included in the UOD limit, which is seasonal in the summer months.

**Table 2-1.**  
**WWTF SPDES Effluent Limitations (Partial List)**

Parameter	Limit	Units	Limit	Units	Notes
Flow	6.8	mgd			12 month rolling average
CBOD <sub>5</sub>	25	mg/l <sup>(1)</sup>	1,400	lbs/d	Monthly average
CBOD <sub>5</sub>	40	mg/l	2,300	lbs/d	7 day average
UOD <sup>(2)</sup>			4,900	lbs/d	Monthly average
TSS <sup>(3)</sup>	30	mg/l	1,700	lbs/d	Monthly average
TSS	45	mg/l	2,600	lbs/d	7 day average
Disinfection required					All year
pH	6.0-9.0	SU			Range
Solids, Settable	0.3	ml/l			Daily maximum

Notes: <sup>(1)</sup> mg/l = Milligrams per liter  
<sup>(2)</sup> UOD =  $1.5 \times \text{CBOD}_5 + 4.5 \times \text{TKN}$   
<sup>(3)</sup> TSS = Total suspended solids

Limit is seasonal from June 1<sup>st</sup> to October 31<sup>st</sup>

Source: September 2005 SPDES Permit – NY 002 9351

## 2.2 Flow and Loading Data

Discharge Monitoring Reports (DMRs) and data provided by plant staff were analyzed to estimate the current influent flows and loads (CBOD<sub>5</sub>, TSS and TKN) to the WWTF during the period of July 2005 through June 2008. The average of 3 years of data was calculated and selected to represent the existing conditions of the WWTF for the development of the BioWin model. Table 2-2 summarizes the influent data. Please note that the WWTP is monitored based on a 12-month rolling average flow and not an average daily flow (as shown in the Table).

**Table 2-2.**

**Current WWTF Influent Data**

Date	Avg Flow (mgd)	CBOD <sub>5</sub> (lb/d)	TSS (lb/d)	TKN (lb/d)
July-05	4.4	6,124	8,965	790
August-05	3.8	6,877	9,742	840
September-05	3.5	7,039	7,611	885
October-05	7.4	5,882	7,107	819
November-05	5.5	7,082	8,704	NA
December-05	6.5	6,543	5,996	NA
January-06	8.0	6,995	6,706	NA
February-06	6.5	6,443	5,672	NA
March-06	4.4	6,110	7,080	NA
April-06	5.2	6,891	6,977	NA
May-06	5.3	6,366	7,250	NA
June-06	6.2	6,046	7,596	1,240
July-06	4.9	5,872	6,530	1,027
August-06	4.2	5,036	5,280	909
September-06	4.8	5,741	6,584	1,004
October-06	5.2	6,890	7,632	1,090
November-06	5.8	5,834	7,292	NA
December-06	4.4	5,909	7,414	NA
January-07	5.6	5,928	6,067	NA
February-07	4.4	5,053	6,289	NA
March-07	6.5	5,510	7,076	NA
April-07	7.1	4,700	6,246	NA
May-07	4.9	5,462	5,624	NA
June-07	4.2	5,437	6,955	883
July-07	3.9	4,464	5,833	880
August-07	4.0	4,917	5,907	990
September-07	3.7	4,494	5,664	831
October-07	4.0	5,499	5,532	1,200

Date	Avg Flow (mgd)	CBOD <sub>5</sub> (lb/d)	TSS (lb/d)	TKN (lb/d)
November-07	4.5	4,496	5,313	NA
December-07	5.2	5,079	6,338	NA
January-08	5.9	5,316	7,088	NA
February-08	8.2	5,957	6,368	NA
March-08	8.6	4,071	6,142	NA
April-08	6.3	5,657	9,516	NA
May-08	5.1	4,929	6,000	NA
June-08	4.1	4,531	6,746	852
<b>05-08 Average</b>	<b>5.4</b>	<b>5,723</b>	<b>6,810</b>	<b>934</b>
<b>05-08 Max Month</b>	<b>8.6</b>	<b>7,082</b>	<b>9,742</b>	<b>1,240</b>
<b>05-08 Min Month</b>	<b>3.5</b>	<b>4,071</b>	<b>5,280</b>	<b>790</b>

Effluent data from the same period were analyzed to determine the average, minimum and maximum monthly flows and loads. Raw influent sewage phosphorus and alkalinity data were collected during May and June 2006. The WWTF operators collected dissolved oxygen (DO) concentrations in the primary effluent, the aeration basins and the aeration basins effluent and the corresponding air supplied by the blowers. Data were used to develop and calibrate the model.

A summary of influent flow and pollutant concentrations used in the model for current conditions is shown in Table 2-3.

**Table 2-3.**

**Current WWTF Influent Average Parameters**

Parameter	Value	Unit
Flow	5.4	mgd
CBOD <sub>5</sub>	127	mg/l
TSS	151	mg/l
TKN	21	mg/l
P <sup>(1)</sup>	14	mg/l
Alkalinity	1.3	mmol/l <sup>(2)</sup>

Notes: <sup>(1)</sup> P = Phosphorus  
<sup>(2)</sup> mmol/l = Milli moles per liter

## 2.3 Primary Clarifier Performance

Operators provided Malcolm Pirnie with TSS removal performance data of the existing primary clarifiers that were collected during May and June 2006. Table 2-4, on the next page, shows the collected data from the influent and primary effluent and the removal efficiency. Typically, a well-designed and maintained primary clarifier will remove approximately 60 percent (%) of the influent TSS and 30% of the influent BOD<sub>5</sub>. The removal efficiency of the primary clarifiers at the WWTF was 62% on average during the monitored period.

Table 2-4.

**Primary Clarifiers Performance Data**

Date	Influent Flow (mgd)	Raw Influent TSS (mg/l)	Primary Effluent TSS (mg/l)	Removal Efficiency (%)
5/26/2006 6:00 a.m.	4.81	37	35	5%
5/26/2006 9:00 a.m.	5.40	162	38	77%
5/26/2006 2:00 p.m.	7.10	280	50	82%
5/30/2006 9:00 a.m.	4.80	183	45	75%
6/6/2006 1:30 p.m.	5.45	155	68	56%
6/8/2006 2:00 p.m.	7.80	185	64	65%
6/13/2006 9:00 a.m.	5.20	160	46	71%
6/14/2006 10:00 a.m.	5.80	156	42	73%
6/19/2006 10:00 a.m.	5.10	156	59	62%
6/22/2006 8:00 a.m.	4.30	87	40	54%
Average				62%

## 2.4 Current WWTF Operation

Currently, the WWTF has no ammonia or TKN effluent limit. Monitoring on the TKN effluent concentration is required, and the TKN concentration is included in the calculation of the UOD limit.

The end section of each aeration basin can be operated as anoxic, when the air is switched off in the area separated by a baffle from the rest of the tank. This mode of operation is used when high concentrations of nitrates and nitrites, produced by nitrification, are followed by denitrification in the secondary clarifiers, causing a release

of nitrogen gas and subsequent floating sludge. WWTF personnel reported that this mode of operation was not used during the past year, and the activated sludge tanks were run at aerobic conditions. Therefore, the BioWin model was developed for a conventional activated sludge process without denitrification.

## 2.5 WWTF Recycle Flows

The BioWin model was developed for the liquid stream of the WWTF. Flows of filtrate and supernatant from the gravity thickener, the DAF, and the belt filter press (BFP) are recycled to the wet stream for treatment. These flows typically have high concentrations and can have a significant effect on the WWTF.

Data for the belt filter press and DAF recycle were collected by the WWTF operators by collecting aeration tanks influent data before and after the recycles contribution. A mass balance was performed to estimate the recycle contribution, and the results were used to specify a BFP and DAF recycle, which was included in the model as an additional influent to the aeration tanks. Data for the gravity thickener supernatant were not available, and were not included in the model. Please note that any process or loading changes that are input into the WWTF BioWin model, will result in changes that need to be manually input into the model for the recycle streams.

## **3.0 Evaluation of the Existing Aeration System**

### **3.1 Facility Description**

The existing secondary treatment system at the Kingston WWTF consists of the following equipment and tankage:

- Three 392,360 gallon aeration basins.
- Three air blowers (two duty, one stand-by) and ceramic fine bubble diffusers.
- Four secondary clarifiers.
- Four return activated sludge (RAS) pumps (three duty, one stand-by).

The three aeration basins are each 111 feet (ft.) by 30 ft. with a 15.75 ft. side water depth. Air is provided to each aeration basin for both oxygen and mixing by air blowers through a ceramic fine bubble diffuser system. Effluent from the aeration basins is distributed equally to the secondary clarifiers.

Three RAS pumps are used to return sludge from the secondary clarifiers to the aeration basins. The current return sludge flowrate is maintained at approximately 1 mgd.

### **3.2 Evaluation of Existing Facility**

The wet stream of the WWTF was modeled for existing conditions with BioWin 2.2 (BioWin), a computer process-modeling tool by EnviroSim, Inc. BioWin is an integrated simulation program that can be utilized to model complex wastewater treatment facilities or individual processes. Malcolm Pirnie simulated the aeration basins with a fine bubble aeration system and a dissolved oxygen (DO) concentration of 3 mg/l. All BioWin simulation outputs are included in Appendix B.

The liquid stream of the WWTF was modeled as primary clarifiers, followed by bioreactors (aeration basins) and secondary clarifiers, with return activated sludge to the bioreactors. Elements data such as volume and depth were entered for each element. Operating parameters such as temperature, dissolved oxygen setpoint, biological kinetic parameters, and airflow requirements were entered into the bioreactor element. A steady-

state condition was used to simulate the plant based on constant influent loading inputs. The model was run for summer conditions, with an average wastewater temperature of 20 degrees Celsius.

The model was calibrated based on data collected by WWTF personnel during May and June 2006.

Air requirements vary on the type of diffusers being provided, the alpha correction factor for oxygen transfer efficiency in wastewater, ambient temperature, and target DO concentrations. Some important assumptions for calculating air requirements include the following:

- Alpha factor  $\alpha$  = oxygen transfer correction factor for wastewater = 0.5.
- Beta factor  $\beta$  = salinity-surface tension corrector factor = 0.95.
- Average aeration basin DO concentration of 3 mg/l.
- Ceramic type air diffusers.

The total oxygen transfer rate (OTR) in lb O<sub>2</sub>/hr and the actual air supply rate in standard cubic feet per minute (scfm) were determined. Table 3-1 summarizes the calculated air supply rate for existing conditions.

**Table 3-1.**

**Aeration Basin Oxygen Requirements**

Condition	Air Flow (mgd)	OTR (lbO <sub>2</sub> /hr) <sup>(1)</sup>	Air (scfm) <sup>(1)</sup>	bhp
Current	5.4	230	1,725	80

Note: (1) A safety factor of 1.1 has been applied to the air supply rate modeled with BioWin 2.2.

Table 3-1 also provides a summary of the break horsepower required for average conditions. The blower break horsepower requirements were calculated on the estimated aeration system headloss and a generic blower mechanical efficiency of 80 percent.

### 3.3 Mixing Requirements

The aeration equipment must be able to provide the oxygen needed for the process and must be able to deliver the energy needed to maintain mixed conditions within the reactor therefore keeping the mixed liquor suspended solids (MLSS) in suspension.

In fine bubble aeration systems, the air requirement to ensure proper mixing is achieved is approximately 0.12 scfm/min per square feet of tankage, for a grid system where the diffusers are installed uniformly along the aeration basin bottom (WEF Manual of Practice No. 8). Based on the areas of the three basins, a minimum of 1,200 scfm (50 hp) must be supplied for mixing.

## **4.0 Evaluation of Future Conditions**

### **4.1 Future Flows**

The WWTF is committed to receive additional flows from neighboring communities.

Additional flows are as follows:

- Town of Esopus: 276,000 gallons per day (gpd)
- Town of Ulster: 75,000 gpd
- East Kingston: 40,000 gpd

The Town of Esopus currently contributes an influent flow of approximately 470,000 gpd to the WWTF. The City has entered into an agreement with the Town of Esopus to receive up to 646,000 gpd; therefore, for the purpose of this study, the full contract amount has been used. In addition, the City has allocated an additional flow of 100,000 gpd for the Town of Esopus's future use. The City has entered into an agreement with the Town of Ulster to receive 75,000 gpd in the future. Again the full contract amount has been utilized for the purpose of this study. The East Kingston flow was calculated as 80% of the maximum water usage permit of 50,000 gpd, as provided by City of Kingston personnel.

In addition to the flows identified above, three new developments are planned for construction partially within the limits of the City of Kingston. The developments are planning to discharge sewage to the Kingston WWTF for treatment and disposal. The developments will be constructed in stages; for the purpose of this study, flows from the completed Sailor's Cove and Parking Garage developments were considered. Flow from Hudson Landing development was added by phases to determine which phase can be completed without exceeding the WWTF capacity.

The estimated total flows from the developments are:

- Sailor's Cove: 110,410 gpd
- Parking Garage: 58,550 gpd

■ Hudson Landing:	
Phase 1	105,570 gpd
Phase 2	91,820 gpd
Phase 3	124,210 gpd
Phase 4	66,500 gpd
Phase 5	55,530 gpd
Total:	443,630 gpd

Flow data for Sailor's Cove and Hudson Landing were based on the Feasibility Study for Water Supply and Distribution and Wastewater Collection Disposal for The Landing at Kingston and Ulster by Brinnier and Larios, P.C. Flow data for the Parking Garage development were based on the number of proposed units, the average household size for the City of Kingston as published by the U.S. Census Bureau, and the average daily individual wastewater flow rate.

## 4.2 Future Loadings

Future CBOD<sub>5</sub>, TSS and TKN loads to the WWTF were estimated based on the values provided by the Great Lakes – Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers Recommended Standards for Wastewater Facilities (10 States Standards):

- 0.17 pounds of BOD<sub>5</sub> per capita per day.
- 0.20 pounds of TSS per capita per day.

Concentrations were calculated based on a typical average daily flow of 100 gal per capita per day. Table 4-1 summarizes the future influent data.

**Table 4-1.**  
**Future WWTF Influent Data**

Contribution	Avg Flow <sup>(2)</sup> (mgd)	CBOD <sub>5</sub> (mg/l)	CBOD <sub>5</sub> (lb/d)	TSS (mg/l)	TSS (lb/d)	TKN (mg/l)	TKN (lb/d)
Current WWTF	5.4	127 <sup>(1)</sup>	5,723	151 <sup>(1)</sup>	6,810	21 <sup>(1)</sup>	934
Esopus	0.276	203	467	240	552	29	67
Ulster	0.075	203	127	240	150	29	18
East Kingston	0.04	203	68	240	80	29	10
Hudson Landing	0.444	203	751	240	888	29	108

Contribution	Avg Flow <sup>(2)</sup> (mgd)	CBOD <sub>5</sub> (mg/l)	CBOD <sub>5</sub> (lb/d)	TSS (mg/l)	TSS (lb/d)	TKN (mg/l)	TKN (lb/d)
Sailor's Cove	0.110	203	187	240	221	29	27
Parking Garage	0.059	203	99	240	117	29	14
<b>Total</b>	<b>6.40</b>	<b>139</b>	<b>7,422</b>	<b>165</b>	<b>8,819</b>	<b>22.1</b>	<b>1,179</b>

Notes: <sup>(1)</sup> Concentration based on actual data collected by the City of Kingston.  
<sup>(2)</sup> Average daily dry weather flow.

### 4.3 Evaluation of Future Loads

A separate simulation was developed to assess the effect the projected loads have on the capacity of the WWTF. The simulation was developed based on the BioWin model that was calibrated with current data and utilizing the current mode of operation and current return flows. The BioWin model was used to simulate the different build-out phases of The Landing to determine which phase can be completed within the permitted limits of the existing WWTF. Results were compared to current conditions. The BioWin simulation output for future conditions is included in Appendix C.

The main effluent parameters predicted by the BioWin model are shown in Table 4-2.

**Table 4-2.**

#### **BioWin Model Effluent Simulation Results**

Effluent Parameters	Unit	SPDES Limits	SPDES Limits with Safety Factor <sup>(1)</sup>	Predicted Current Values	Predicted Future Values at Phase 4	Predicted Future Values at Full Build-Out
CBOD <sub>5</sub>	mg/l	25	23	8.3	9.6	9.7
CBOD <sub>5</sub>	lb/d	1,400	1,260	373	509	516
TSS	mg/l	30	27	17.4	19.5	19.5
TSS	lb/d	1,700	1,530	784	1,032	1,041
TKN	mg/l	None	None	11.1	15.2	15.5
TKN	lb/d	None	None	502	806	830
UOD	lb/d	4,900	4,410	2,820	4,392	4,509

Note: <sup>(1)</sup> SPDES limitations with 10% safety factor.

The model shows that, at the completion of Hudson Landing building development, the predicted effluent concentrations and loads for CBOD<sub>5</sub> and TSS will continue to meet the current SPDES limits. However, the UOD load will approach the permitted limit of

4,900 lbs per day. Considering a safety factor of 10%, the UOD will be exceeding 4,410 lb/d, which corresponds to 90% of the permitted limit.

Up to four phases can be completed without exceeding the UOD load within 10% of the limit. As shown in Table 4-2, at the completion of Phase 4 the predicted UOD load is 4,392 lb/d.

The increased UOD of the effluent is mostly due to an increase in the effluent ammonia concentration, as represented by TKN. With higher influent flow and loads, the WWTF's nitrification capacity decreases, resulting in higher effluent ammonia; and therefore, higher effluent TKN. The effluent ammonia concentration increases as a result of reduced nitrification caused by a decreased solids residence time (SRT) in the aeration basins after the CBOD<sub>5</sub> is consumed. The reduced SRT causes the removal efficiency for TKN to decrease from approximately 46% to less than 30% at full build-out.

Table 4-3 summarizes the calculated air supply rate for future conditions.

**Table 4-3.**

**Aeration Basin Oxygen Requirements at Future Conditions**

Condition	Flow (mgd)	OTR (lbO <sub>2</sub> /hr) <sup>(1)</sup>	Air (scfm) <sup>(1)</sup>	bhp
Future	6.4	235	1,800	80

Note: <sup>(1)</sup> A safety factor of 1.1 has been applied to the air supply rate modeled with BioWin 2.2.

The required air for the aeration tanks at future flows and loads at completion of Hudson Landing development is slightly greater than the air required for current conditions. The current air blowers appear to have sufficient capacity to handle the future loads, however, a more detailed review of the air piping and diffuser system needs to be completed in order to determine if 1,800 scfm can be delivered to the basins in consideration of the headloss in the system.

According to 10 States Standards, the permissible aeration tank capacity and loading for a conventional complete mix system is 40 lb BOD<sub>5</sub>/d·1000 ft<sup>3</sup>.

Table 4-4 shows the capacity of the aeration tanks at current and future flows and loads to the aeration basins based on 10 States Standards. Both current and future flows and loads are within the 10 States Standards recommended loading rate to the aeration basins.

Table 4-4.

#### Aeration Tanks Capacity

Condition	Flow (mgd)	CBOD <sub>5</sub> Loading (lb/d)	10-States Standards Permissible Loading (lb BOD <sub>5</sub> /d·1000 ft <sup>3</sup> )	Actual Aeration Tank Loading (lb CBOD <sub>5</sub> /d·1000 ft <sup>3</sup> )
Current	5.4	4,006	40	25.4
Future	6.4	5,195	40	32.9

## 4.4 Evaluation of Modified Process Operations for Future Loading Conditions

Additional simulations were developed to predict the WWTF capacity at different modes of operation at the future projected flows and loads. Simulated operation scenarios included plug flow with increased SRT, contact stabilization, and step feed.

SOLIDS RETENTION TIME

### 4.4.1 Plug Flow with Increased SRT

Under this scenario, the WWTF will continue operating as conventional plug flow activated sludge, with the influent introduced to the front of the aeration tanks. The flow in the BioWin model was increased to 1.25 mgd. For the purpose of this study, it was assumed that the WAS remains at the current flow of 60,000 gpd and that the removal efficiencies of the primary and the secondary clarifiers remain unvaried.

BETWEEN ACTIVATED SLUDGE

WASER ACTIVATED SLUDGE

The SRT for this operation mode increases to 3.0 days, compared to an SRT of 2.3 days of the WWTF at current operation and future flows and loads. The MLSS concentration increases from 1,060 mg/l to 1,250 mg/l. The main effluent parameters predicted by the BioWin model are shown in Table 4-5. The BioWin simulation output for future conditions at increased SRT is included in Appendix D.

Table 4-5.

**BioWin Model Effluent Results for Plug Flow with Increased SRT**

Effluent Parameters	Unit	SPDES Limits	SPDES Limits with Safety Factor <sup>(1)</sup>	Predicted Future Values at Current Operation	Predicted Future Values at Increased SRT Operation
CBOD <sub>5</sub>	mg/l	25	23	9.7	10.8
CBOD <sub>5</sub>	lb/d	1,400	1,260	516	578
TSS	mg/l	30	27	19.5	23.9
TSS	lb/d	1,700	1,530	1,041	1,276
TKN	mg/l	None	None	15.5	11.8
TKN	lb/d	None	None	830	630
UOD	lb/d	4,900	4,410	4,509	3,703

Notes: <sup>(1)</sup> SPDES limitations with 10% safety factor.

The model shows that the operation of the WWTF at higher SRT will result in lower effluent TKN; and therefore, a lower predicted UOD load. The TKN removal for this mode of operation is 47%.

The required RAS pumps flow in the simulation increased approximately 20% from 1 mgd to 1.25 mgd. There are four existing RAS pumps with VFDs, which currently operate at approximately 50% of their speed. As reported by WWTF staff, pumps were sized to handle a total of 8 mgd, therefore it is estimated that the current RAS pumps could handle the increased flow. It should be noted that increasing the SRT results in increasing the MLSS of the aeration basins, which could result in higher risk of solids washout during wet weather flows and will require more operator supervision of the wastewater treatment process.

Table 4-6 summarizes the calculated air supply rate for future conditions at increased SRT operation.

**Table 4-6.**

**Aeration Basin Oxygen Requirements at Increased SRT**

Condition	Flow (mgd)	OTR (lbO <sub>2</sub> /hr) <sup>(1)</sup>	Air (scfm) <sup>(1)</sup>	bhp
Future at Increased SRT	6.4	290	2,270	100

Note: <sup>(1)</sup> A safety factor of 1.1 has been applied to the air supply rate modeled with BioWin 2.2.

The required air for the aeration tanks at increased SRT for future flows and loads is greater than the air required for the current operation.

There are four existing blowers with VFDs. Currently, one or two blowers operate at average influent flows and loads, and up to four blowers operate at peak conditions. The current air blowers appear to be undersized to handle the future flow and loads at the increased SRT mode of operation. Further investigation, including a study of the air pipes configuration and headloss, would be required to analyze the blowers capacity.

#### **4.4.2 Contact Stabilization**

To convert the WWTF to a contact stabilization operation, the aeration tanks would be separated into a contact zone, with approximately one third of the aeration tanks volume; and a stabilization zone, with approximately two thirds of the aeration tanks volume. The influent is fed to the contact zone and the RAS is returned to the stabilization zone. The stabilized activated sludge is mixed with the influent wastewater in the contact zone.

The BioWin model was developed assuming that the RAS flow will remain unvaried at 1 mgd and the WAS remains at the current flow of 60,000 gpd; in addition, it was assumed that the removal efficiencies of the primary and the secondary clarifiers remain unvaried. The BioWin simulation output for future conditions at contact stabilization operation is included in Appendix E.

The SRT for this operation mode increases to 12.3 days, compared to an SRT of 2.3 days of the WWTF at current operation and future flows and loads. The MLSS concentration increases from 1,060 mg/l to 5,830 mg/l in the stabilization zone. The MLSS

concentration in the contact zone is lower at 800 mg/l. The main effluent parameters predicted by the BioWin model are shown in Table 4-7.

**Table 4-7.**

**BioWin Model Effluent Results for Contact Stabilization**

<b>Effluent Parameters</b>	<b>Unit</b>	<b>SPDES Limits</b>	<b>SPDES Limits with Safety Factor <sup>(1)</sup></b>	<b>Predicted Future Values at Current Operation</b>	<b>Predicted Future Values at Contact Stabilization Operation</b>
CBOD <sub>5</sub>	mg/l	25	23	9.7	18.0
CBOD <sub>5</sub>	lb/d	1,400	1,260	516	960
TSS	mg/l	30	27	19.5	14.5
TSS	lb/d	1,700	1,530	1,041	775
TKN	mg/l	None	None	15.5	20.4
TKN	lb/d	None	None	830	1,091
UOD	lb/d	4,900	4,410	4,509	6,350

Notes: <sup>(1)</sup> SPDES limitations with 10% safety factor.

The model shows that the operation of the WWTF at contact stabilization will result in higher effluent CBOD<sub>5</sub> and TKN; and therefore, a higher predicted UOD load. This is likely due to the fact that the shorter contact time limits the amount of soluble BOD<sub>5</sub> degraded and ammonia oxidation. Therefore, contact stabilization is not a recommended process operation for improving limits compliance at the future loads and flows.

#### **4.4.3 Step Feed**

Step feed is a modification of the conventional plug flow process in which the settled wastewater is introduced to three feed points in the aeration tanks to equalize the food to microorganisms (F/M) ratio.

The BioWin model was developed assuming that the RAS flow will remain unvaried at 1 mgd and the WAS remains at the current flow of 60,000 gpd; in addition, it was assumed that the removal efficiencies of the primary and the secondary clarifiers remain unvaried. The BioWin simulation output for future conditions at step feed operation is included in Appendix F.

The SRT for this operation mode increases to 3.6 days, compared to an SRT of 2.3 days of the WWTF at current operation and future flows and loads. The MLSS concentration increases from 1,060 mg/l to 2,300 mg/l. The main effluent parameters predicted by the BioWin model are shown in Table 4-8. *was it - 004 ?*

**Table 4-8.**

**BioWin Model Effluent Results for Step Feed**

Effluent Parameters	Unit	SPDES Limits	SPDES Limits with Safety Factor <sup>(1)</sup>	Predicted Future Values at Current Operation	Predicted Future Values at Step Feed Operation
CBOD <sub>5</sub>	mg/l	25	23	9.7	8.6
CBOD <sub>5</sub>	lb/d	1,400	1,260	516	461
TSS	mg/l	30	27	19.5	18.5
TSS	lb/d	1,700	1,530	1,041	988
TKN	mg/l	None	None	15.5	11.4
TKN	lb/d	None	None	830	608
UOD	lb/d	4,900	4,410	4,509	3,426

Notes: <sup>(1)</sup> SPDES limitations with 10% safety factor.

The model shows that the operation at step feed will improve the WWTF removal of CBOD<sub>5</sub>, TSS and TKN, resulting in a lower predicted UOD load.

The step feed process has the capability of carrying a higher solids inventory, and thus a higher SRT for the same volume as the conventional plug flow process.

Table 4-9 summarizes the calculated air supply rate for future conditions at step feed operation.

**Table 4-9.**

**Aeration Basin Oxygen Requirements at Step Feed**

Condition	Flow (mgd)	OTR (lbO <sub>2</sub> /hr) <sup>(1)</sup>	Air (scfm) <sup>(1)</sup>	bhp
Future at Step Feed	6.4	310	2,480	110

Note: <sup>(1)</sup> A safety factor of 1.1 has been applied to the air supply rate modeled with BioWin 2.2.

The required air for the aeration tanks at increased SRT for future flows and loads is greater than the air required for the current operation.

The current air blowers appear to be undersized to handle the future flow and loads at the step feed mode of operation. A more detailed review of the air piping and diffuser system needs to be completed in order to determine if 2,480 scfm can be delivered to the basins in consideration of the headlosses in the system. Most likely additional diffusers and reconfiguration of the air piping will be required to deliver the air to the basins.

## **4.5 Summary and Conclusions**

The future summertime conditions represent the worst case scenario due to temperature dependency of the saturation of oxygen in water. For three months of the year, the WWTF will be at approximately 93% of the available capacity with current operational strategy of conventional plug flow activated sludge.

New York Codes, Rules and Regulations (NYCRR) Part 750-2 require that WWTFs that receive or exceed the actual design influent loading for BOD<sub>5</sub> or TSS for any eight calendar months must develop a facility plan for future expansion. Based on the results of the model, Malcolm Pirnie is predicting that the WWTF will be at or near capacity during the summer months. The model is based on a margin of safety of 10%.

The BioWin model was developed with available data supplied by WWTF personnel. The model results represent a snapshot of the average current operations based on average data and removal efficiencies. It should be noted that during flow or loading conditions different from those used in the model (i.e., diurnal and seasonal variation), the effluent concentrations would vary from those shown.

The City has the ability to treat loads, with a high level of confidence, from the proposed projects through Phase 4 of the development of Hudson Landing without significantly changing the operation of the WWTF. The BioWin model indicates that the WWTF, as currently operated in a conventional plug flow process configuration, is not capable of

treating all the loads from the City, its contracted amounts from neighboring communities and the full build-out of the proposed developments with an acceptable margin of error for safety. Operating in this manner is not recommended at this time without performing pilot testing or additional sampling to accurately determine the kinetic factors assumed for the development of the model.

Please note that, while the reduced SRT is cited as the cause of the reduced nitrification performance, this study has not specifically evaluated the WWTF's hydraulic capacity and has, instead, focused exclusively on the biological treatment capacity of the WWTF.

The concept of changing the mode of operation of the secondary activated sludge system to either plug flow mode with a higher RAS rate or step feed mode results in a significant decrease of the UOD effluent discharge load due to increased nitrification. It is noted that increasing the MLSS concentration of the aeration basins will result in a process that will require more operator attention during wet weather events; however, the WWTF should be capable of maintaining permit limits. Solids washout, a concern of the WWTF operators, may be reduced through a combination of strategies.

First is the use of selector zones for the step feed mode of operation (as used by the City of Philadelphia at the Northeast Water Pollution Control Plant). Selector zone operation allows the operators to temporarily retain solids by feeding the basins at the 3<sup>rd</sup> gate during wet weather conditions. In fact, the operational changes at the Philadelphia plant have resulted in significant savings for the City and the plant has performed consistently in compliance during wet weather events. There is a temporary reduction in the amount of treatment the wastewater receives as the SRT is reduced, however, during wet weather events, the wastewater is diluted and this reduces the likelihood of solids washout of the secondary clarifiers.

Secondly, a 5<sup>th</sup> secondary clarifier should be added to the wastewater treatment plant to increase the hydraulic retention time of the clarifiers and reduce the surface over flow rate. A 5<sup>th</sup> clarifier presents some issues during design and construction to ensure that

flows are evenly distributed and solids are evenly withdrawn from each basin. Due to space limitations, the City would need to construct a clarifier that uses the hydraulic principles of similitude, as the dimensions of the existing tanks cannot be replicated, or additional land would have to be purchased adjacent to the wastewater treatment plant.

Lastly, the addition of polymer in the secondary clarifiers in combination with the first two suggestions will assist in settling during wet weather events. Improvements to the aeration basins include a detailed analysis of the blowers, air piping and diffuser system, weir gates and control systems to treat loads from Hudson Landing after Phase 4. Additional improvements to the WWTF include modifications to the RAS/WAS pumping systems, expanding the basement where the RAS/WAS pumps are located, and miscellaneous electrical upgrades. Automation and SCADA system improvements may offset some of the additional operator attention required during wet weather events.

**APPENDIX A**

SPDES Permit

**New York State Department of Environmental Conservation**  
**Division of Environmental Permits, 4<sup>th</sup> Floor**  
625 Broadway, Albany, New York 12233-1750  
Phone: (518) 402-9167 • FAX: (518) 402-9168  
Website: [www.dec.state.ny.us](http://www.dec.state.ny.us)



*Certified Mail*

11 August 2005

City of Kingston  
Attn: Mayor  
420 Broadway  
Kingston, NY 12401

Re: EBPS SPDES Permit Modification  
DEC ID: 3-5108-00044/00003  
SPDES: NY 0029351  
Kingston Wastewater Treatment  
Plant

Dear Permittee:

Enclosed, please find the final modified State Pollutant Discharge Elimination System (SPDES) permit for the City of Kingston Wastewater Treatment Plant. Your permit was modified in accordance with the Environmental Benefit Permit Strategy.

Please feel free to contact me at the above address with further questions on the administration of this permit. Should you have technical questions on permit conditions, please contact your permit drafter, Chris Keim, at 518-402-8116.

Sincerely,



Andrea Sheeran Glick  
Division of Environmental Permits

cc:  
L. Meyerson, R3 RWM  
M. Duke, R3 RPA  
A. Fuchs, CO BWP, Chief WWPS  
C. Keim, CO BWP, Permit Drafter  
Ulster County DOH  
Jeff Gretz, USEPA Region II  
S. Strobe, BWP  
C:11



NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION  
**State Pollutant Discharge Elimination System (SPDES)**  
**DISCHARGE PERMIT**  
Special Conditions

Industrial Code: 4952  
Discharge Class (CL): 05  
Toxic Class (TX): T  
Major Drainage Basin: 13  
Sub Drainage Basin: 06  
Water Index Number: H-139  
Compact Area:

SPDES Number: NY-002 9351  
DEC Number: 3-5108-00044/0  
Effective Date (EDP): 05/01/2003  
Expiration Date (ExDP): 05/01/2008  
Modification Dates: 09/01/2005

This SPDES permit is issued in compliance with Title 8 of Article 17 of the Environmental Conservation Law of New York State and in compliance with the Clean Water Act, as amended, (33 U.S.C. §1251 et.seq.) (hereinafter referred to as "the Act").

**PERMITTEE NAME AND ADDRESS**

Name: City of Kingston  
Street: 420 Broadway  
City: Kingston

Attention: Mayor

State: NY Zip Code: 12401

is authorized to discharge from the facility described below:

**FACILITY NAME AND ADDRESS**

Name: Kingston Wastewater Treatment Plant  
Location (C,T,V): Kingston (C)  
Facility Address: 91-129 East Strand Avenue  
City: Kingston

County: Ulster

State: NY Zip Code: 12401

NYTM -E:

NYTM -N:

From Outfall No.: 002 at Latitude: 41 ° 55 ' 12 " & Longitude: 73 ° 58 ' 42 "

into receiving waters known as: Rondout Creek Class: C

and; (list other Outfalls, Receiving Waters & Water Classifications)

Additional discharges are listed on page 2 of this permit.

in accordance with: effluent limitations; monitoring and reporting requirements; other provisions and conditions set forth in this permit; and 6 NYCRR Part 750-1.2(a) and 750-2.

**DISCHARGE MONITORING REPORT (DMR) MAILING ADDRESS**

Mailing Name: City of Kingston  
Street: 91-129 East Strand Avenue  
City: Kingston  
Responsible Official or Agent: George B. Cacchio

State: NY Zip Code: 12401  
Phone: (845) 331-2490

This permit and the authorization to discharge shall expire on midnight of the expiration date shown above and the permittee shall not discharge after the expiration date unless this permit has been renewed, or extended pursuant to law. To be authorized to discharge beyond the expiration date, the permittee shall apply for permit renewal not less than 180 days prior to the expiration date shown above.

**DISTRIBUTION:**

Bureau of Water Permits  
Leonard Meyerson, RWE  
Margaret Duke, RPA  
EPA Reg. II-Jeff Gratz  
Dutchess County Health Dept.

Permit Administrator: William R. Adriance, Chief Permit Administrator	
Address: 625 Broadway Albany, NY 12233-1750	
Signature: <i>William R. Adriance</i>	Date: 8/11/05

### ADDITIONAL OUTFALLS

Outfall No.	Description	Latitude/Longitude	Receiving Stream/Class
005	Old Hasbrouck Avenue CSO	41°54'35"/ 73°58'57"	Rondout Creek / C
006	Broadway CSO	41°54'34"/ 73°58'59"	Rondout Creek / C
007	Hunter Street CSO	41°54'25"/ 73°59'22"	Rondout Creek / C
011	Wilbur Avenue CSO	41°54'06"/ 74°00'08"	Rondout Creek / C

**PERMIT LIMITS, LEVELS AND MONITORING DEFINITIONS**

OUTFALL	WASTEWATER TYPE	RECEIVING WATER	EFFECTIVE	EXPIRING		
	This cell describes the type of wastewater authorized for discharge. Examples include process or sanitary wastewater, storm water, non-contact cooling water.	This cell lists classified waters of the state to which the listed outfall discharges.	The date this page starts in effect. (e.g. EDP or EDPM)	The date this page is no longer in effect. (e.g. ExDP)		
PARAMETER	MINIMUM	MAXIMUM	UNITS	SAMPLE FREQ.	SAMPLE TYPE	
e.g. pH, TRC, Temperature, D.O.	The minimum level that must be maintained at all instants in time.	The maximum level that may not be exceeded at any instant in time.	SU, °F, mg/l, etc.			
PARAMETER	EFFLUENT LIMIT	PRACTICAL QUANTITATION LIMIT (PQL)	ACTION LEVEL	UNITS	SAMPLE FREQUENCY	SAMPLE TYPE
	Limit types are defined below in Note 1. The effluent limit is developed based on the more stringent of technology-based limits, required under the Clean Water Act, or New York State water quality standards. The limit has been derived based on existing assumptions and rules. These assumptions include receiving water hardness, pH and temperature; rates of this and other discharges to the receiving stream; etc. If assumptions or rules change the limit may, after due process and modification of this permit, change.	For the purposes of compliance assessment, the analytical method specified in the permit shall be used to monitor the amount of the pollutant in the outfall to this level, provided that the laboratory analyst has complied with the specified quality assurance/quality control procedures in the relevant method. Monitoring results that are lower than this level must be reported, but shall not be used to determine compliance with the calculated limit. This PQL can be neither lowered nor raised without a modification of this permit.	Type I or Type II Action Levels are monitoring requirements, as defined below in Note 2, that trigger additional monitoring and permit review when exceeded.	This can include units of flow, pH, mass, Temperature, concentration. Examples include µg/l, lbs/d, etc.	Examples include Daily, 3/week, weekly, 2/month, monthly, quarterly, 2/yr and yearly.	Examples include grab, 24 hour composite and 3 grab samples collected over a 6 hour period.

**Note 1: DAILY DISCHARGE:** The discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for the purposes of sampling. For pollutants expressed in units of mass, the 'daily discharge' is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurement, the 'daily discharge' is calculated as the average measurement of the pollutant over the day.

**DAILY MAX.:** The highest allowable daily discharge. **DAILY MIN.:** The lowest allowable daily discharge.

**MONTHLY AVG:** The highest allowable average of daily discharges over a calendar month, calculated as the sum of each of the daily discharges measured during a calendar month divided by the number of daily discharges measured during that month.

**7 DAY ARITHMETIC MEAN (7 day average):** The highest allowable average of daily discharges over a calendar week.

**30 DAY GEOMETRIC MEAN:** The highest allowable geometric mean of daily discharges over a calendar month, calculated as the antilog of : the sum of the log of each of the daily discharges measured during a calendar month divided by the number of daily discharges measured during that month.

**7 DAY GEOMETRIC MEAN:** The highest allowable geometric mean of daily discharges over a calendar week.

**RANGE:** The minimum and maximum instantaneous measurements for the reporting period must remain between the two values shown.

**Note 2: ACTION LEVELS:** Routine Action Level monitoring results, if not provided for on the Discharge Monitoring Report (DMR) form, shall be appended to the DMR for the period during which the sampling was conducted. If the additional monitoring requirement is triggered as noted below, the permittee shall undertake a short-term, high-intensity monitoring program for the parameter(s). Samples identical to those required for routine monitoring purposes shall be taken on each of at least three consecutive operating and discharging days and analyzed. Results shall be expressed in terms of both concentration and mass, and shall be submitted no later than the end of the third month following the month when the additional monitoring requirement was triggered. Results may be appended to the DMR or transmitted under separate cover to the same address. If levels higher than the Action Levels are confirmed, the permit may be reopened by the Department for consideration of revised Action Levels or effluent limits. The permittee is not authorized to discharge any of the listed parameters at levels which may cause or contribute to a violation of water quality standards. **TYPE I:** The additional monitoring requirement is triggered upon receipt by the permittee of any monitoring results in excess of the stated Action Level. **TYPE II:** The additional monitoring requirement is triggered upon receipt by the permittee of any monitoring results that show the stated action level exceeded for four of six consecutive samples, or for two of six consecutive samples by 20 % or more, or for any one sample

## PERMIT LIMITS, LEVELS AND MONITORING

OUTFALL No.	LIMITATIONS APPLY:	RECEIVING WATER	EFFECTIVE	EXPIRING
002	<input checked="" type="checkbox"/> All Year <input type="checkbox"/> Seasonal from _____ to _____	Rondout Creek	08/01/2003	08/01/2008

PARAMETER	EFFLUENT LIMIT					MONITORING REQUIREMENTS				FN
	Type	Limit	Units	Limit	Units	Sample Frequency	Sample Type	Location		
								Inf.	Eff.	
Flow	Monthly Average	monitor	MGD			Continuous	Recorder		X	
Flow	12 Month Rolling Average	6.8	MGD			1/month	calculated		X	
CBOD <sub>5</sub>	Monthly Average	25	mg/l	1400	lbs/d	2/week	24 hr. Comp	X	X	(1)
CBOD <sub>5</sub>	7 day average	40	mg/l	2300	lbs/d	2/week	24 hr. Comp		X	
UOD	Monthly Average			4900	lbs/d					(2)(3)
Solids, Suspended	Monthly Average	30	mg/l	1700	lbs/d	2/week	24 hr. Comp	X	X	(1)
Solids, Suspended	7 day average	45	mg/l	2600	lbs/d	2/week	24 hr. Comp		X	
Solids, Settleable	Daily Max.	0.3	ml/l			3/day	Grab		X	
Nitrogen, TKN (as N)	Daily Max.	Monitor	mg/l			2/week	24 hr. Comp		X	(3)(4)
Ammonia as NH3	Daily Max.	Monitor	mg/l			2/week	24 hr. Comp		X	
Copper, Total	Daily Max.			2.0	lbs/day	1/month	24 hr. Comp		X	
Lead	Daily Max			0.45	lbs/day	1/month	24 hr. Comp		X	
Zinc	Daily Max			monitor	lbs/day	1/quarter	24 hr. Comp		X	
Temperature	Daily Max.	Monitor	Deg. F			3/day	Grab		X	
pH	Range	6.0 - 9.0	SU			3/day	Grab		X	
Effluent Disinfection required: [ X ] All Year [ ] Seasonal from _____ to _____										
Coliform, Fecal	30 day geometric mean	200	No./100 ml			2/week	Grab		X	
Coliform, Fecal	7 day geometric mean	400	No./100 ml			2/week	Grab		X	
Chlorine, Total Residual	Daily Max.	0.9	mg/l			3/day	Grab		X	(5)

## FOOTNOTES:

- (1) and effluent shall not exceed 15 % and 15 % of influent concentration values for CBOD<sub>5</sub> & TSS respectively.
- (2) Ultimate Oxygen Demand shall be computed as follows:  $UOD = 1.5 \times CBOD_5 + 4.5 \times TKN$  (Total Kjeldahl Nitrogen)
- (3) Limit is seasonal from June 1<sup>st</sup> - October 31<sup>st</sup>
- (4) Samples for CBOD & TKN are to be collected at the same time to calculate UOD.
- (5) Monitoring of these parameters is only required when chlorine is used for disinfection.

## SCHEDULES OF COMPLIANCE

The permittee shall comply with the following schedules.

### a) Hi-Intensity Sampling Schedule

Action Code	Outfall Number(s)	Compliance Action	Due Date						
	002	<p>The permittee shall conduct sampling for the following parameters detected in the WWTP effluent and listed in the permit application. Sampling shall be once per week for a period of 3 months. The permittee shall submit the results of the analyses along with the daily flow:</p> <table><thead><tr><th><u>Parameter</u></th><th><u>EPA Method of Analysis Required</u></th><th><u>Sample Type</u></th></tr></thead><tbody><tr><td>Phenolics, Total</td><td>420.1</td><td>24 hr. Comp.</td></tr></tbody></table> <p>The Department may reopen and modify the permit upon review of the sampling results.</p>	<u>Parameter</u>	<u>EPA Method of Analysis Required</u>	<u>Sample Type</u>	Phenolics, Total	420.1	24 hr. Comp.	EDPM + 6 month
<u>Parameter</u>	<u>EPA Method of Analysis Required</u>	<u>Sample Type</u>							
Phenolics, Total	420.1	24 hr. Comp.							

### b) Hi-Intensity Sampling Schedule

Action Code	Outfall Number(s)	Compliance Action	Due Date						
	002	<p>The Department is conducting a program to collect low level mercury data. The permittee shall conduct sampling for the following parameters as indicted below. Sampling shall be once per month for a period of 3 months.</p> <table><thead><tr><th><u>Parameter</u></th><th><u>EPA Method of Analysis Required</u></th><th><u>Sample Type</u></th></tr></thead><tbody><tr><td>Mercury</td><td>1631</td><td>Grab</td></tr></tbody></table> <p>The Department may reopen and modify the permit upon review of the sampling results.</p>	<u>Parameter</u>	<u>EPA Method of Analysis Required</u>	<u>Sample Type</u>	Mercury	1631	Grab	EDPM + 6 month
<u>Parameter</u>	<u>EPA Method of Analysis Required</u>	<u>Sample Type</u>							
Mercury	1631	Grab							

## c) Sewer System Evaluation Study

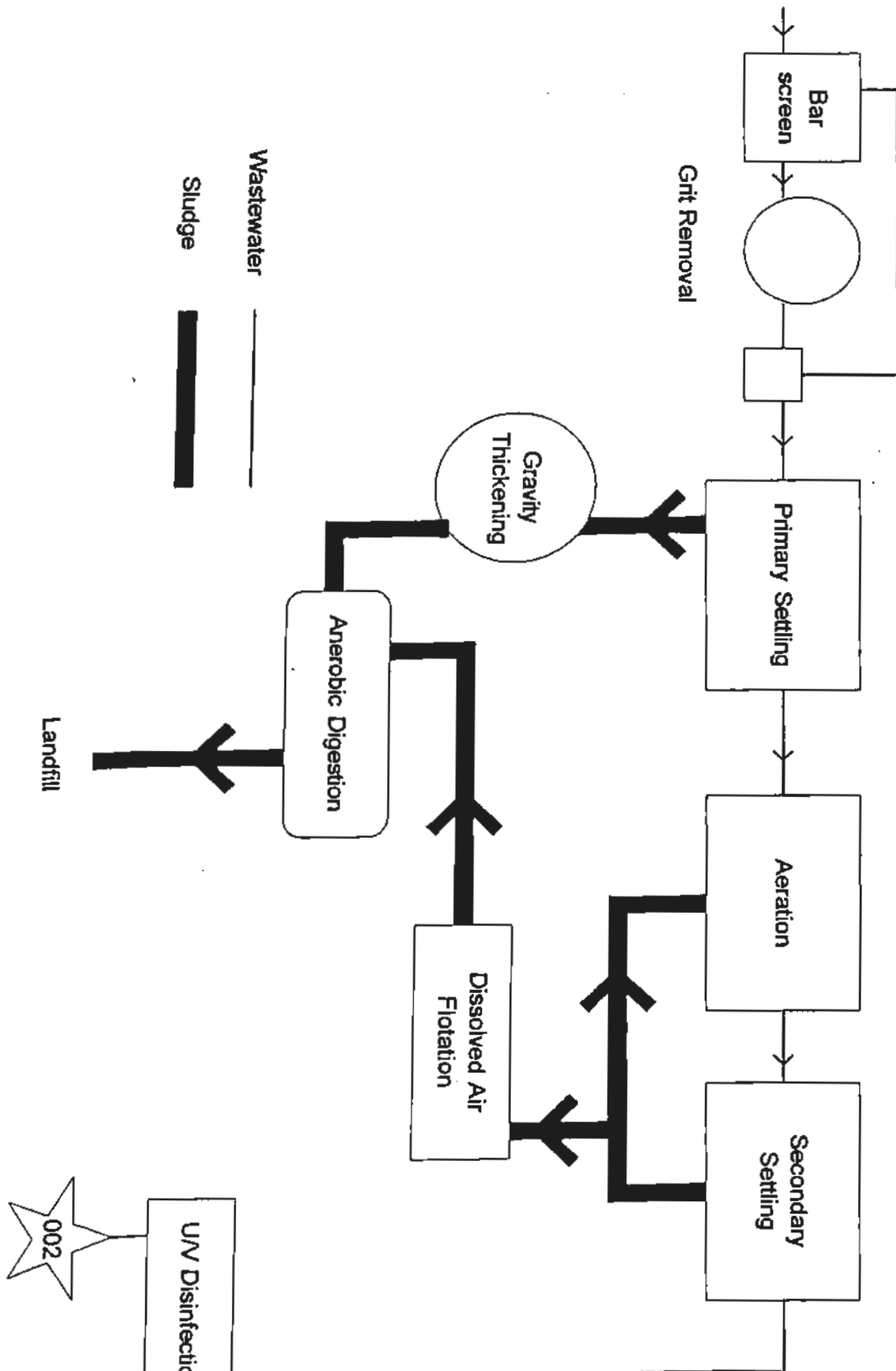
Action Code	Outfall Number(s)	Compliance Action	Due Date
	ALL	The permittee shall submit an approvable up to date SSES (sewer system evaluation study) Engineering Report that specifically targets sewers that have experienced deterioration and that includes a prioritized schedule of implementation to rehabilitate the sewers that require work. An approvable report will focus on the sections of the collection system that are the oldest.	EDPM + 12 months

The above compliance actions are one time requirements. The permittee shall comply with the above compliance actions to the Department's satisfaction once. When this permit is administratively renewed by NYSDEC letter entitled "SPDES NOTICE/RENEWAL APPLICATION/PERMIT", the permittee is not required to repeat the submission. The above due dates are independent from the effective date of the permit stated in the letter of "SPDES NOTICE/RENEWAL APPLICATION/PERMIT."

- c) The permittee shall submit a written notice of compliance or non-compliance with each of the above schedule dates no later than 14 days following each elapsed date, unless conditions require more immediate notice as prescribed in 6 NYCRR Part 750-1.2(a) and 750-2. All such compliance or non-compliance notification shall be sent to the locations listed under the section of this permit entitled RECORDING, REPORTING AND ADDITIONAL MONITORING REQUIREMENTS. Each notice of non-compliance shall include the following information:
1. A short description of the non-compliance;
  2. A description of any actions taken or proposed by the permittee to comply with the elapsed schedule requirements without further delay and to limit environmental impact associated with the non-compliance;
  3. A description or any factors which tend to explain or mitigate the non-compliance; and
  4. An estimate of the date the permittee will comply with the elapsed schedule requirement and an assessment of the probability that the permittee will meet the next scheduled requirement on time.
- d) The permittee shall submit copies of any document required by the above schedule of compliance to NYSDEC Regional Water Engineer at the location listed under the section of this permit entitled RECORDING, REPORTING AND ADDITIONAL MONITORING REQUIREMENTS and to the Bureau of Water Permits, 625 Broadway, Albany, N.Y. 12233-3505, unless otherwise specified in this permit or in writing by the Department.

## MONITORING LOCATIONS

The permittee shall take samples and measurements, to comply with the monitoring requirements specified in this permit, at the location 002 specified below:



**BEST MANAGEMENT PRACTICES FOR COMBINED SEWER OVERFLOWS**

The permittee shall implement the following Best Management Practices (BMPs). These BMPs are designed to implement operation & maintenance procedures, utilize the existing treatment facility and collection system to the maximum extent practicable, and implement sewer design, replacement and drainage planning, to maximize pollutant capture and minimize water quality impacts from combined sewer overflows. The BMPs are equivalent to the "Nine Minimum Control Measures" required under the USEPA National Combined Sewer Overflow policy. The EPA's policy is available at [http://cfpub.epa.gov/npdes/cso/cpolicy.cfm?program\\_id=5](http://cfpub.epa.gov/npdes/cso/cpolicy.cfm?program_id=5).

1. **CSO Maintenance/Inspection** - The permittee shall develop a written maintenance and inspection program for all CSOs listed on page 2 of this permit. This program shall include all regulators tributary to these CSOs, and shall be conducted during periods of both dry and wet weather. This is to insure that no discharges occur during dry weather and that the maximum amount of wet weather flow is conveyed to the City of Kingston POTW for treatment. This program shall consist of inspections with required repair, cleaning and maintenance done as needed. This program shall consist of weekly inspections.

Inspection reports shall be completed indicating visual inspection, any observed flow, incidence of rain or snowmelt, condition of equipment and work required. These reports shall be in a format approved by the Regional Office and submitted to the Region with the monthly operating report (Form 92-15-7).

2. **Maximum Use of Collection System for Storage** - The permittee shall optimize the collection system by operating and maintaining it to minimize the discharge of pollutants from CSOs. It is intended that the maximum amount of in-system storage capacity be used (without causing service backups) to minimize CSOs and convey the maximum amount of combined sewage to the treatment plant in accordance with Item 4 below.

This shall be accomplished by an evaluation of the hydraulic capacity of the system but should also include a continuous program of flushing or cleaning to prevent deposition of solids and the adjustment of regulators and weirs to maximize storage.

3. **Industrial Pretreatment** - The approved Industrial Pretreatment Program shall consider CSOs in the calculation of local limits for indirect discharges. Discharge of persistent toxics upstream of CSOs will be in accordance with guidance under (NYSDEC Division of Water Technical and Operational Guidance Series (TOGS) 13.8 New Discharges to POTWs. (<http://www.dec.state.ny.us/website/dow/togs/togs138.pdf>) For industrial operations characterized by use of batch discharge, consideration shall be given to the feasibility of a schedule of discharge during conditions of no CSO. For industrial discharges characterized by continuous discharge, consideration must be given to the collection system capacity to maximize delivery of waste to the treatment plant. Non-contact cooling water should be excluded from the combined system to the maximum extent practicable. Direct discharges of cooling water must apply for a SPDES permit.

To the maximum extent practicable, consideration shall be given to maximize the capture of industrial waste containing toxic pollutants and this wastewater should be given priority over residential/commercial service areas for capture and treatment by the POTW. For new industry, these factors shall be considered in siting with preference to service by areas not tributary to CSOs or having sufficient capacity to deliver all industrial wastewater during all conditions to the POTW.

4. **Maximize Flow to POTW** - Factors cited in Item 2. above shall also be considered in maximizing flow to the POTW. Maximum delivery to the POTW is particularly critical in treatment of "first-flush" flows. The treatment plant shall be capable of receiving and treating: the peak design hydraulic loading rates for all process units; i.e., a minimum of 13.6 MGD through the plant headworks; a minimum of 13.6 MGD through the primary treatment works and disinfection works if applicable; and a minimum of 10.2 MGD through the secondary treatment works during wet weather. The collection system and headworks must be capable of delivering these flows during wet weather. If the permittee cannot deliver maximum design flow for treatment, the permittee shall submit a plan and schedule for accomplishing this requirement within 6 months after the effective date of this permit.

5. Wet Weather Operating Plan - The permittee shall maximize treatment during wet weather events. This shall be accomplished by having a wet weather operating plan containing procedures so as to operate unit processes to treat maximum flows while not appreciably diminishing effluent quality or destabilizing treatment upon return to dry weather operation. The wet weather operations plan shall be submitted to the Regional Office and the Bureau of Water Permits, 625 Broadway, Albany, NY 12233-3505 for review and approval within 12 months after the effective date of this permit.

The submission of a wet weather operating plan is a one time requirement that shall be done to the Department's satisfaction once. However, a revised wet weather operating plan must be submitted whenever the POTW and/or sewer collection system is replaced or modified. When this permit is administratively renewed by NYSDEC letter entitled "SPDES NOTICE/RENEWAL APPLICATION/PERMIT", the permittee is not required to repeat the submission. The above due dates are independent from the effective date of the permit stated in the letter of "SPDES NOTICE/RENEWAL APPLICATION/PERMIT".

6. Prohibition of Dry Weather Overflow - Dry weather overflows from the combined sewer system are prohibited. The occurrence of any dry weather overflow shall be promptly abated and reported to the NYSDEC Regional Office in accordance with 6 NYCRR Part 750-2.7.
7. Control of Floatable and Settleable Solids - The discharge of floating solids, oil and grease, or solids of sewage origin which cause deposition in the receiving waters, is a violation of the NYS Narrative Water Quality Standards contained in Part 703. As such, the permittee shall implement best management practices in order to eliminate or minimize the discharge of these substances. All of the measures cited in Items 1, 2, 4 & 5 above shall constitute approvable "BMPs" for mitigation of this problem. If aesthetic problems persist, the permittee should consider additional BMP's including but not limited to: street sweeping, litter control laws, installation of floatables traps in catch basins (such as hoods), booming and skimming of CSOs, and disposable netting on CSO outfalls. In cases of severe or excessive floatables generation, booming and skimming should be considered an interim measure prior to implementation of final control measures. Public education on harmful disposal practices of personal hygienic devices may also be necessary including but not limited to: public broadcast television, printed information inserts in sewer bills, or public health curricula in local schools.
8. Combined Sewer System Replacement - Replacement of combined sewers shall not be designed or constructed unless approved by NYSDEC. When replacement of a combined sewer is necessary it shall be replaced by separate sanitary and storm sewers to the greatest extent possible. These separate sanitary and storm sewers shall be designed and constructed simultaneously but without interconnections to maximum extent practicable. When combined sewers are replaced, the design should contain cross sections which provide sewage velocities which prevent deposition of organic solids during low flow conditions.
9. Combined Sewer/Extension - Combined sewer/extension, when allowed should be accomplished using separate sewers. These sanitary and storm sewer extensions shall be designed and constructed simultaneously but without interconnections. No new source of storm water shall be connected to any separate sanitary sewer in the collection system.

If separate sewers are to be extended from combined sewers, the permittee shall demonstrate the ability of the sewerage system to convey, and the treatment plant to adequately treat, the increased dry-weather flows. Upon a determination by the Regional Water Engineer an assessment shall be made by the permittee of the effects of the increased flow of sanitary sewage or industrial waste on the strength of CSOs and their frequency of occurrence including the impacts upon best usage of the receiving water. This assessment should use techniques such as collection system and water quality modeling contained in the 1999 Water Environment Federation Manual of Practice FD-17 entitled, Prevention and Control of Sewer System Overflows, 2<sup>nd</sup> edition.

10. Sewage Backups - If, there are documented, recurrent instances of sewage backing up into house(s) or discharges of raw sewage onto the ground surface from surcharging manholes, the permittee shall, upon letter notification from DEC, prohibit further connections that would make the surcharging/back-up problems worse.
11. Septage and Hauled Waste - The discharge or release of septage or hauled waste upstream of a CSO is prohibited.
12. Control of Run-off - It is recommended that the impacts of run-off from development and re-development in areas served by combined sewers be reduced by requiring compliance with the New York Standards for Erosion and Sediment Control (<http://www.dec.state.ny.us/website/dow/toolbox/escstandards/index.html>) and the quantity control requirements included in the New York State Stormwater Management Design Manual (<http://www.dec.state.ny.us/website/dow/toolbox/swmanual/>).
13. Public Notification - Within 12 months of the effective date of this permit, the permittee shall install and maintain identification signs at all CSO outfalls owned and operated by the permittee. The permittee shall place the signs at or near the CSO outfalls and ensure that the signs are easily readable by the public. The signs shall have **minimum** dimensions of eighteen inches by twenty four inches (18" x 24") and shall have white letters on a green background and contain the following information:

<b>N.Y.S. PERMITTED DISCHARGE POINT</b>	
(wet weather discharge)	
SPDES PERMIT No.: NY _____	
OUTFALL No. : _____	
For information about this permitted discharge contact:	
Permittee Name:	
Permittee Contact:	
Permittee Phone:	(     ) - ### - ####
OR:	
NYSDEC Division of Water Regional Office Address :	
NYSDEC Division of Water Regional Phone: (     ) - ### - ####	

The permittee shall implement a public notification program to inform citizens of the location and occurrence of CSO events. This program shall include a mechanism (public media broadcast, standing beach advisories, newspaper notice etc.) to alert potential users of the receiving waters affected by CSOs. The program shall include a system to determine the nature and duration of conditions that are potentially harmful to users of these receiving waters due to CSOs.

14. Characterization and Monitoring - The permittee shall characterize the combined sewer system, determine the frequency of overflows, and identify CSO impacts in accordance with Combined Sewer Overflows, Guidance for Nine Minimum Controls, EPA, 1995, Chapter 10. These are minimum requirements, more extensive characterization and monitoring efforts which may be required as part of the Long Term Control Plan.

15. Annual report - The permittee shall submit an annual report summarizing implementation of the above best management practices (BMPs). The report shall list existing documentation of implementation of the BMPs and shall be submitted by January 31<sup>st</sup> of each year to the Regional office listed on the Recording, Reporting and Additional Monitoring page of this permit and to the Bureau of Water Permits, 625 Broadway, Albany, NY 12233-3505. Examples of recommended documentation of the BMPs are found in Combined Sewer Overflows, Guidance for Nine Minimum Controls (NMC), EPA, 1995. You may obtain an electronic copy of the NMC guidance at <http://www.epa.gov/npdes/pubs/owm0030.pdf>. For guidance, a BMP checklist is available from DEC at <http://www.dec.state.ny.us/website/dow/csobmp.pdf>. You must submit a completed copy of this checklist along with your annual report. The actual documentation shall be stored at a central location and be made available to DEC upon request.

## LONG TERM CONTROL PLAN

The permittee shall develop a Long-Term Control Plan in accordance with the 1994 National CSO Control Policy and the Guidance For Long-Term Control Plan, EPA, September, 1995, which will address the elements contained in Sections A through D below:

### I. Phase I

#### A. Public Participation

The permittee shall prepare and implement a public participation plan that outlines how the permittee will ensure participation of the public throughout the LTCP development process.

#### B. Combined Sewer System (CSS) Characterization

The permittee shall develop and implement a plan that will result in a comprehensive characterization of the Combined Sewer System (CSS), including the interceptor sewer system, developed through any means appropriate to establish the existing baseline conditions, evaluate the effectiveness of the CSO technology-based controls (BMPs), and determine the baseline conditions upon which the LTCP will be based. The characterization shall adequately address the response of the CSS to various precipitation events; identify the number, location, frequency, and characteristics of CSOs; and identify water quality impacts that result from CSOs.

To complete the characterization, the permittee must:

Identify sensitive areas to which its CSOs occur. These areas shall include waters with threatened or endangered species and their designated critical habitat, waters with primary contact recreation, public drinking water intakes or their designated protection areas and any other areas identified by the permittee or permitting authority, in coordination with appropriate State or Federal agencies.

The following methods may be employed to characterize the combined sewer system:

1. Rainfall Records Review - The permittee may examine the complete rainfall records for the geographic areas of the CSS and evaluate the flow variations in the receiving water body to correlate between the CSOs and receiving water conditions.

2. CSS Records Review - The permittee may review and evaluate all available CSS records and undertake field inspections and other necessary activities to identify the number, location, and frequency of CSOs and their location relative to sensitive areas and to pollution sources, such as significant industrial users, in the collection system.

3. CSO and Water Quality Monitoring - The permittee may develop a monitoring program that measures the frequency, duration, flow rate, volume, and pollutant concentration of CSOs and assesses the impact of the CSOs on receiving waters. Monitoring shall be performed at a representative number of CSOs for a representative number of events. The monitoring program may include CSOs and ambient receiving waterbody monitoring.

4. CSS and Receiving Water Modeling - The permittee may employ models, which include appropriate calibration and verification with field measurements, to aid in the characterization. If models are used, they shall be identified by the permittee along with an explanation of why the model was selected and used in the characterization.

Existing information applicable to the development of the CSS may be incorporated into the characterization.

#### C. CSO Control Alternatives

The permittee must choose one of the following two approaches to demonstrate compliance with the National CSO Control Policy:

1. a. Demonstrative Approach - The permittee shall develop CSO control alternative(s) that would meet EPA's requirements for the demonstrative approach. The alternative(s) should demonstrate each of the following: (1) the planned control program is adequate to meet WQS and protect designated uses, and (2) the CSO discharges remaining after implementation of planned control programs will not preclude the attainment of WQS or the receiving waters designated uses or contribute to impairment, and (3) the planned control program will provide the maximum pollution reduction benefits reasonably attainable, and, if applicable, (4) the planned control program is designed to allow cost effective expansion or retrofitting if additional controls are subsequently determined to be necessary to meet WQS or designated uses.

b. Presumptive Approach - Alternatively, the permittee shall develop CSO control alternative(s) that would meet one of EPA's criteria for the presumptive approach. These criteria consist of: (1) no more than 4-6 overflow events per year that do not receive minimum treatment; or (2) the elimination or capture for minimum treatment of no less than 85% by volume of the combined sewage collected during precipitation events on a system-wide annual average basis; or (3) the elimination or removal of no less than the mass of the pollutants, identified as causing water quality impairment during the characterization, monitoring, and modeling effort. Minimum treatment for (1) and (2) above is defined as: primary clarification to remove floatables and settleable solids, solids and floatables disposal, and disinfection of effluent, if necessary, to meet water quality standards (WQS) according to 6NYCRR Part 703.

2. Evaluation of CSO Control Alternative(s) - If the permittee has considered more than one alternative, the permittee shall evaluate: each of the alternatives developed in accordance with C.1 a. or b. to select the CSO controls that will ensure compliance with CWA requirements; and the expansion of the POTW treatment plant(s) secondary and primary capacity.

3. Identification of the Selected CSO Control Alternatives - The permittee shall submit a description of the alternatives that were considered, the chosen alternative(s) that will be implemented and the reasoning behind the selection.

4. Schedule - The permittee shall submit a schedule for design and construction of the selected CSO control facilities, and/or implementation of other measures, as well as submittal of the post-construction monitoring program and operational plan in accordance with D. below. The schedule may be phased based on the relative importance of the adverse impacts on water quality standards and on the permittee's financial capability.

#### D. Subsequent Requirements

1. Operational Plan - The wet weather operating plan that is required in the permittee's CSO Best Management Practices shall be required to be updated as a result of modifications to the CSS made during the implementation of the LTCP.

2. Post-Construction Compliance Monitoring Program - The permittee shall develop and submit a post-construction monitoring program that (a) is adequate to ascertain the effectiveness of the CSO controls and (b) can be used to verify attainment of water quality standards. The program shall include a plan that details the monitoring protocols to be followed, including CSO and ambient monitoring and, where appropriate, other monitoring protocols, such as biological assessments, whole effluent toxicity testing, and sediment sampling.

#### II. LTCP Compliance Dates

All submittals shall be delivered to the Regional Water Engineer and the Bureau of Water Permits, 625 Broadway, Albany, NY 12233-3505.

A. The permittee shall schedule a meeting with the SPDES permit writer, which shall be held no later than EDPM + 6 months to discuss the CSS Characterization, CSO Control Alternatives, and the Approaches, in order to facilitate development of an approvable CSS Characterization, Monitoring, and Modeling Plan and LTCP.

B. The permittee shall submit an approvable Public Participation Plan by EDPM + 6 months, which shall be developed in accordance with the requirements in Section I. A. above.

C. The permittee shall submit an approvable CSS Characterization, Monitoring, and Modeling Plan by EDPM + 12 months, which shall be developed in accordance with the requirements specified in Sections I. B. above.

D. Upon DEC approval of the CSS Characterization, Monitoring and Modeling Plan + 12 months, the permittee shall submit a completed, approvable Phase I LTCP, which shall be developed in accordance with the requirements specified in Sections I. B. & C. above.

#### III. Phase II

Upon DEC approval of the Phase I LTCP, the construction and implementation schedule shall become part of, and enforceable under, this SPDES permit.

## TOXICITY TESTING PROGRAM, TIER 2 - CHRONIC TEST

### Effluent Toxicity Monitoring Requirements

Outfall Number	Effluent Parameters (Units)	Reason for Testing Requirement	Sample Frequency	Sample Type
002	Toxicity (% Effluent)	Existing pretreatment program. STP > 1.0 MGD	Quarterly, for a period of one year, in years ending in 1 and 6.	24 hr. Composite/ static renewal

- (a) The effluent toxicity monitoring program shall begin within 3 months of this page becoming effective in this permit. Subsequent modification or renewal of this permit does not reset or revise the deadline(s) set forth in the preceding sentence unless a new deadline is set explicitly by such modification or renewal.
- (b) The results of each toxicity test shall be submitted no later than 60 days following the end of each test period. These reports shall be submitted to the NYS DEC Regional Water Engineer at 200 White Plains Rd. 5<sup>th</sup> Floor Tarrytown, NY 10591-5805 and to the Toxicity Testing Unit, Bureau of Watershed Assessment and Research, 625 Broadway, Albany, NY 12233-3502.
- (c) Effluent toxicity shall mean the toxicity of the effluent in chronic static renewal tests as specified in *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms*, Third Edition, EPA/600/4-91/002 (1994), the EPA Chronic Manual for Marine Organisms (EPA/600/4-91/003(1994), or the most recent editions (herein referred to as the EPA Chronic Manuals). Both a vertebrate and invertebrate species shall be used for the tests. Where the outfall being tested discharges to estuarine or ocean waters, marine organisms shall be tested. Where the outfall being tested discharges to fresh waters, freshwater organisms shall be tested. Each test run shall be 'bracketed' with a test of pure effluent and a test of effluent diluted sufficiently such that at least one diluted sample shows no toxic effects. Appropriate dilutions between the endpoints shall be tested to allow calculation of the Maximum Allowable Waste Concentration. Dilution water shall be collected according to the EPA Chronic Manuals. Receiving water shall be used as dilution water unless the Department approves a different source. Effluent sampling and holding shall be done as outlined in of the EPA Chronic Manuals. Any deviation from procedures in the EPA Chronic Manuals requires prior written approval by the Department.
- (d) The Maximum Allowable Waste Concentration (MAWC) in % Effluent, for both a vertebrate and an invertebrate species, shall be determined and reported. The MAWC in % Effluent shall be compared to the calculated Instream Waste Concentration (IWC) of the effluent. The IWC in % Effluent shall be determined using the daily average effluent flow at the time of sampling and a critical receiving water flow of 33.2 cubic feet per second for Rondout Creek.
- (e) Where practicable, monitoring of chemical and physical parameters limited in this permit shall be coordinated so that the resulting analysis is also representative of the samples used for toxicity testing.
- (f) Discharges which use chlorination as part of the waste treatment process for disinfection should be dechlorinated prior to toxicity testing or samples shall be taken immediately prior to the chlorination system.
- (g) In accordance with NYSDEC guidance, the Department may require the permittee to conduct additional toxicity testing. If such additional testing is necessary, the permittee shall be notified in writing by the NYS DEC Regional Water Engineer. The written notification shall include the reason(s) why such testing is required.

## TOXICITY REDUCTION EVALUATION COMPLIANCE SCHEDULE

- (a) In accordance with Department guidance on whole effluent toxicity monitoring and control, the Department will evaluate the results of acute and/or chronic toxicity testing of discharges authorized by this permit. Based on this evaluation, the Department may require the permittee to perform a Toxicity Reduction Evaluation (TRE). Should a TRE be required, the permittee shall be notified in writing by the NYS DEC Regional Water Engineer. The written notification shall include the reasons why the TRE is required.
- (b) Within 60 days of the date of the written notification from the NYS DEC Regional Water Engineer in (a), the permittee shall submit an approvable proposal for Toxicity Reduction Evaluation to the Bureau of Watershed Assessment and Research, 625 Broadway, Albany, NY 12233-3502. The TRE proposal shall be directed towards identifying the source of the toxicity, describing procedures to reduce the toxicity to an acceptable level, identifying monitoring parameters suitable for insuring control of the toxicity, and proposing a schedule for completing the TRE.
- (c) Within 14 days of receipt of written approval of the TRE proposal from the DEC Regional Water Engineer, the permittee shall implement the approved TRE proposal in accordance with the approved schedule.
- (d) The completed TRE, including data findings and recommendations for corrective action, permit limits, and proposed self-monitoring requirements shall be submitted to the Bureau of Watershed Assessment and Research at the address noted in (b) on this page. The Department will review the TRE and may modify the permit, in accordance with applicable law & regulation, to incorporate one or more of the following: substance specific numerical limits, toxicity limits, monitoring requirements, and/or a schedule of compliance that will ensure acceptable toxicity levels of the effluent.

## PRETREATMENT PROGRAM IMPLEMENTATION REQUIREMENTS

- A. DEFINITIONS. Generally, terms used in this Section shall be defined as in the General Pretreatment Regulations (40 CFR Part 403). Specifically, the following definitions apply to terms used in this Section (PRETREATMENT PROGRAM IMPLEMENTATION REQUIREMENTS):
1. Categorical Industrial User (CIU)- an industrial user of the POTW that is subject to Categorical Pretreatment Standards under 40 CFR 403.6 and 40 CFR Chapter I, Subchapter N;
  2. Local Limits - General Prohibitions, specific prohibitions and specific limits as set forth in 40 CFR 403.5.
  3. The Publicly Owned Treatment Works (the POTW) - as defined by 40 CFR 403.3(o) and that discharges in accordance with this permit.
  4. Program Submission(s) - requests for approval or modification of the POTW Pretreatment Program submitted in accordance with 40 CFR 403.11 or 403.18 and approved by letter dated 10/27/99.
  5. Significant Industrial User (SIU) -
    - a. CIUs;
    - b. Except as provided in 40 CFR 403.3(t)(2), any other industrial user that discharges an average of 25,000 gallons per day or more of process wastewater (excluding sanitary, non-contact cooling and boiler blowdown wastewater) to the POTW;
    - c. Except as provided in 40 CFR 403.3(t)(2), any other industrial user that contributes a process wastestream which makes up 5 percent or more of the average dry weather hydraulic or organic capacity of the POTW treatment plant;
    - d. Any other industrial user that the permittee designates as having a reasonable potential for adversely affecting the POTW's operation or for violating a pretreatment standard or requirement.
  6. Substances of Concern - Substances identified by the New York State Department of Environmental Conservation Industrial Chemical Survey as substances of concern.
- B. IMPLEMENTATION. The permittee shall implement a POTW Pretreatment Program in accordance 40 CFR Part 403 and as set forth in the permittee's approved Program Submission(s). Modifications to this program shall be made in accordance with 40 CFR 403.18. Specific program requirements are as follows:
1. Industrial Survey. To maintain an updated inventory of industrial dischargers to the POTW the permittee shall:
    - a. Identify, locate and list all industrial users who might be subject to the industrial pretreatment program from the pretreatment program submission and any other necessary, appropriate and available sources. This identification and location list will be updated, at a minimum, every five years. As part of this update the permittee shall collect a current and complete New York State Industrial Chemical Survey form (or equivalent) from each SIU.
    - b. Identify the character and volume of pollutants contributed to the POTW by each industrial user identified in B.1.a above that is classified as a SIU.
    - c. Identify, locate and list, from the pretreatment program submission and any other necessary, appropriate and available sources, all significant industrial users of the POTW.

2. Control Mechanisms. To provide adequate notice to and control of industrial users of the POTW the permittee shall:
- Inform by certified letter, hand delivery courier, overnight mail, or other means which will provide written acknowledgment of delivery, all industrial users identified in B.1.a. above of applicable pretreatment standards and requirements including the requirement to comply with the local sewer use law, regulation or ordinance and any applicable requirements under section 204(b) and 405 of the Federal Clean Water Act and Subtitles C and D of the Resource Conservation and Recovery Act.
  - Control through permit or similar means the contribution to the POTW by each SIU to ensure compliance with applicable pretreatment standards and requirements. Permits shall contain limitations, sampling frequency and type, reporting and self-monitoring requirements as described below, requirements that limitations and conditions be complied with by established deadlines, an expiration date not later than five years from the date of permit issuance, a statement of applicable civil and criminal penalties and the requirement to comply with Local Limits and any other requirements in accordance with 40 CFR 403.8(f)(1).
3. Monitoring and Inspection. To provide adequate, ongoing characterization of non-domestic users of the POTW, the permittee shall:
- Receive and analyze self-monitoring reports and other notices. The permittee shall require all SIUs to submit self-monitoring reports at least every six months unless the permittee collects all such information required for the report, including flow data.
  - The permittee shall adequately inspect each SIU at a minimum frequency of once per year.
  - The permittee shall collect and analyze samples from each SIU for all priority pollutants that can reasonably be expected to be detectable at levels greater than the levels found in domestic sewage at a minimum frequency of once per year.
  - Require, through permits, each SIU to collect at least one 24 hour, flow proportioned composite (where feasible) effluent sample every six months and analyze each of those samples for all priority pollutants that can reasonably be expected to be detectable in that discharge at levels greater than the levels found in domestic sewage. The permittee may perform the aforementioned monitoring in lieu of the SIU except that the permittee must also perform the compliance monitoring described in 3.c.
4. Enforcement. To assure adequate, equitable enforcement of the industrial pretreatment program the permittee shall:
- Investigate instances of noncompliance with pretreatment standards and requirements, as indicated in self-monitoring reports and notices or indicated by analysis, inspection and surveillance activities. Sample taking and analysis and the collection of other information shall be performed with sufficient care to produce evidence admissible in enforcement proceedings or in judicial actions. Enforcement activities shall be conducted in accordance with the permittee's Enforcement Response Plan developed and approved in accordance with 40 CFR Part 403.
  - Enforce compliance with all national pretreatment standards and requirements in 40 CFR Parts 406 - 471.
  - Provide public notification of significant non-compliance as required by 40 CFR 403.8(f)(2)(vii).
  - Pursuant to 40 CFR 403.5(e), when either the Department or the USEPA determines any source contributes pollutants to the POTW in violation of Pretreatment Standards or Requirements the Department or the USEPA shall notify the permittee. Failure by the permittee to commence an appropriate investigation and subsequent enforcement action within 30 days of this notification may result in appropriate enforcement action against the source and permittee.

5. Record keeping. The permittee shall maintain and update, as necessary, records identifying the nature, character, and volume of pollutants contributed by SIUs. Records shall be maintained in accordance with 6 NYCRR Part 750-2.5(c).
6. Staffing. The permittee shall maintain minimum staffing positions committed to implementation of the Industrial Pretreatment Program in accordance with the approved pretreatment program.
- C. SLUDGE DISPOSAL PLAN. The permittee shall notify NYSDEC, and USEPA as long as USEPA remains the approval authority, 60 days prior to any major proposed change in the sludge disposal plan. NYSDEC may require additional pretreatment measures or controls to prevent or abate an interference incident relating to sludge use or disposal.
- D. REPORTING. The permittee shall provide to the offices listed on the Monitoring, Reporting and Recording page of this permit and to the Chief-Water Permits and Compliance Branch; USEPA Region II; 290 Broadway; New York, NY 10007; a periodic report, prepared and submitted in accordance with the consistent periodic reporting format established by the Department in the document entitled NYSDEC POTW Periodic Pretreatment Report - 1994, that briefly describes the permittee's program activities over the previous year. This report shall be submitted to the above noted offices within 60 days of the end of the reporting period. The reporting period shall be annual, with reporting period(s) ending on February 28th.

The periodic report shall include:

1. Industrial Survey. Updated industrial survey information in accordance with 40 CFR 403.12(I)(1) (including any NYS Industrial Chemical Survey forms updated during the reporting period).
2. Implementation Status. Status of Program Implementation, to include:
  - a. Any interference, upset or permit violations experienced at the POTW directly attributable to industrial users.
  - b. Listing of significant industrial users issued permits.
  - c. Listing of significant industrial users inspected and/or monitored during the previous reporting period and summary of results.
  - d. Listing of significant industrial users notified of promulgated pretreatment standards or applicable local standards who are on compliance schedules. The listing should include for each facility the final date of compliance.
  - e. Summary of POTW monitoring results not already submitted on Discharge Monitoring Reports and toxic loadings from SIU's organized by parameter.
  - f. A summary of additions or deletions to the list of SIUs, with a brief explanation for each deletion.
3. Enforcement Status. Status of enforcement activities to include:
  - a. Listing of significant industrial users in Significant Non-Compliance (as defined by 40 CFR 403.8(f)(2)(vii)) with federal or local pretreatment standards at end of the reporting period.
  - b. Summary of enforcement activities taken against non-complying significant industrial users. The permittee shall provide a copy of the public notice of significant violators as specified in 40 CFR Part 403.8(f)(2)(vii).

**DISCHARGE NOTIFICATION REQUIREMENTS**

- a) The permittee shall, except as set forth in (c) below, maintain the existing identification signs at all outfalls to surface waters, which have not been waived by the Department in accordance with 17-0815-a. The sign(s) shall be conspicuous, legible and in as close proximity to the point of discharge as is reasonably possible while ensuring the maximum visibility from the surface water and shore. The signs shall be installed in such a manner to pose minimal hazard to navigation, bathing or other water related activities. If the public has access to the water from the land in the vicinity of the outfall, an identical sign shall be posted to be visible from the direction approaching the surface water.

The signs shall have minimum dimensions of eighteen inches by twenty four inches (18" x 24") and shall have white letters on a green background and contain the following information:

**N.Y.S. PERMITTED DISCHARGE POINT**

SPDES PERMIT No.: NY \_\_\_\_\_

OUTFALL No. : \_\_\_\_\_

For information about this permitted discharge contact:

Permittee Name: \_\_\_\_\_

Permittee Contact: \_\_\_\_\_

Permittee Phone: (     ) - ### - ####

OR:

NYSDEC Division of Water Regional Office Address :

NYSDEC Division of Water Regional Phone: (     ) - ### - ####

- b) For each discharge required to have a sign in accordance with a), the permittee shall provide for public review at a repository accessible to the public, copies of the Discharge Monitoring Reports (DMRs) as required by the **RECORDING, REPORTING AND ADDITIONAL MONITORING REQUIREMENTS** page of this permit. This repository shall be open to the public, at a minimum, during normal daytime business hours. The repository may be at the business office repository of the permittee or at an off-premises location of its choice (such location shall be the village, town, city or county clerk's office, the local library or other location as approved by the Department). In accordance with the **RECORDING, REPORTING AND ADDITIONAL MONITORING REQUIREMENTS** page of your permit, each DMR shall be maintained on record for a period of five years.
- (c) If, upon November 1, 1997, the permittee has installed signs that include the information required by 17-0815-a(2)(a), but do not meet the specifications listed above, the permittee may continue to use the existing signs for a period of up to five years, after which the signs shall comply with the specifications listed above.
- d) The permittee shall periodically inspect the outfall identification signs in order to ensure that they are maintained, are still visible and contain information that is current and factually correct.

## RECORDING, REPORTING AND ADDITIONAL MONITORING REQUIREMENTS

- a) The permittee shall also refer to 6 NYCRR Part 750-1.2(a) and 750-2 for additional information concerning monitoring and reporting requirements and conditions.
- b) The monitoring information required by this permit shall be summarized, signed and retained for a period of at least five years from the date of the sampling for subsequent inspection by the Department or its designated agent. Also, monitoring information required by this permit shall be summarized and reported by submitting;

☒ (if box is checked) completed and signed Discharge Monitoring Report (DMR) forms for each 1 month reporting period to the locations specified below. Blank forms are available at the Department's Albany office listed below. The first reporting period begins on the effective date of this permit and the reports will be due no later than the 28th day of the month following the end of each reporting period.

☐ (if box is checked) an annual report to the Regional Water Engineer at the address specified below. The annual report is due by February 1 and must summarize information for January to December of the previous year in a format acceptable to the Department.

☐ (if box is checked) a monthly "Wastewater Facility Operation Report..." (form 92-15-7) to the:

☐ Regional Water Engineer and/or ☐ County Health Department or Environmental Control Agency specified below

Send the original (top sheet) of each DMR page to:

Department of Environmental Conservation  
Division of Water  
Bureau of Water Compliance Programs  
625 Broadway  
Albany, New York 12233-3506  
Phone: (518) 402-8177

Send the first copy (second sheet) of each DMR page to:

Department of Environmental Conservation  
Regional Water Engineer  
Region 3  
200 White Plains Road, 5<sup>th</sup> Floor  
Tarrytown, NY 10591-5805  
Phone: (914)-332-1835

Send an additional copy of each DMR page to:  
Ulster County Health Department  
300 Flatbush Avenue  
Kingston, NY 12401

- c) Noncompliance with the provisions of this permit shall be reported to the Department as prescribed in 6 NYCRR Part 750-1.2(a) and 750-2.
- d) Monitoring must be conducted according to test procedures approved under 40 CFR Part 136, unless other test procedures have been specified in this permit.
- e) If the permittee monitors any pollutant more frequently than required by the permit, using test procedures approved under 40 CFR Part 136 or as specified in this permit, the results of this monitoring shall be included in the calculations and recording of the data on the Discharge Monitoring Reports.
- f) Calculation for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified in this permit.
- g) Unless otherwise specified, all information recorded on the Discharge Monitoring Report shall be based upon measurements and sampling carried out during the most recently completed reporting period.
- h) Any laboratory test or sample analysis required by this permit for which the State Commissioner of Health issues certificates of approval pursuant to section five hundred two of the Public Health Law shall be conducted by a laboratory which has been issued a certificate of approval. Inquiries regarding laboratory certification should be sent to the Environmental Laboratory Accreditation Program, New York State Health Department Center for Laboratories and Research, Division of Environmental Sciences, The Nelson A. Rockefeller Empire State Plaza, Albany, New York 12201.

## **APPENDIX B**

BioWin Model Results for Current Conditions

## BioWin user and configuration data

### Project details

Project name: Current Conditions

Plant name: Kingston

Project ref.: BW1

User name: MARPICATI

Created: 5/23/2006

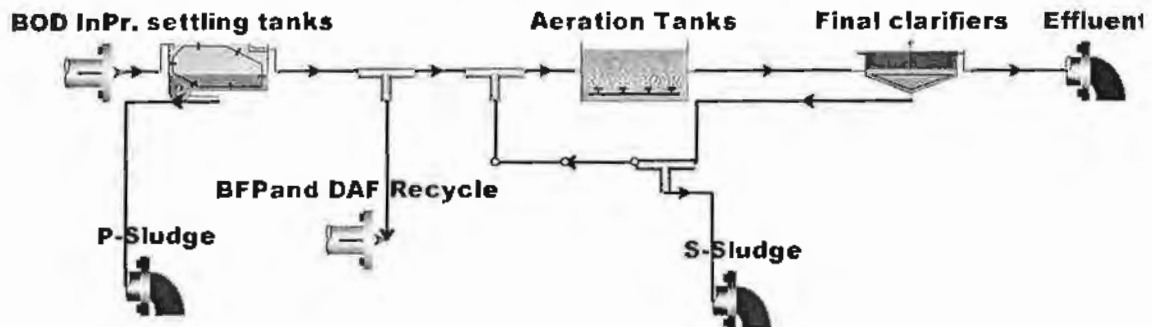
Saved: 8/12/2008

### Steady state solution

SRT: 2.73

Temperature: 20.0

### Flowsheet



## Configuration information for all Ideal primary settling tank units

### Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Pr. settling tanks	0.4625	5472.0000	11.3

### Operating data Average (flow/time weighted as required)

Element name	Split type	Average Split specification
Pr. settling tanks	Flowrate [Under]	0.18

Element name	Percent removal	Blanket fraction
Pr. settling tanks	60.00	0.10

## Configuration information for all Bioreactor units

### Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Aeration Tanks	1.1807	9990.0000	15.8	2264

### Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint
Aeration Tanks	2.0

### Aeration equipment parameters

Element name	$k_1$ in C = $k_1(PC)^{0.25} + k_2$	$k_2$ in C = $k_1(PC)^{0.25} + k_2$	Y in $Kla = C Usg \wedge$ Y - Usg in [m <sup>3</sup> /(m <sup>2</sup> d)]	Area of one diffuser	% of tank area covered by diffusers [%]
Aeration Tanks	2.5656	0.0432	0.8200	0.0410	10.0000

## Configuration information for all Sidestream Mixer units

### Physical data

Element name	Volume[Mil. Gal]	Area[ft <sup>2</sup> ]	Depth[ft]
Sidestream Mixer7	0	N/A	N/A
Sidestream Mixer10	0	N/A	N/A

## Configuration information for all Splitter units

### Physical data

Element name	Volume[Mil. Gal]	Area[ft <sup>2</sup> ]	Depth[ft]
Splitter4	0	N/A	N/A

### Operating data Average (flow/time weighted as required)

Element name	Split type	Average Split specification
Splitter4	Flowrate [Side]	0.065

## Configuration information for all BOD Influent units

### Operating data Average (flow/time weighted as required)

Element name	BOD Influent	BFPand DAF Recycle
Flow	5.4	0.315
Total Carbonaceous BOD mg/L	127.08	167.00
Volatile suspended solids mg/L	113.41	115.00
Total suspended solids mgTSS/L	151.21	433.00
Total Kjeldahl Nitrogen mgN/L	20.74	128.00
Total P mgP/L	14.50	10.00
Nitrate N mgN/L	0.00	0.00
pH	7.60	7.30
Alkalinity mmol/L	1.33	12.00
Calcium mg/L	160.00	160.00
Magnesium mg/L	25.00	25.00
Dissolved oxygen mg/L	0.00	0.00

Element name	BOD Influent	BFPand DAF Recycle
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.2000	0.2000
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1500	0.1500
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.8964	0.6849
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0500	0.0500
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300	0.1300
Fna - Ammonia [gNH3-N/gTKN]	0.7500	0.6600
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.5000	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0000	0.0000
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0350	0.0350
Fpo4 - Phosphate [gPO4-P/gTP]	0.5000	0.5000
FupP - P:COD ratio for influent unbiodegradable part. COD [gP/gCOD]	0.0110	0.0110

FZbh - Non-poly-P heterotrophs	[gCOD/g of total COD]	0.0001	0.0001
FZbm - Anoxic methanol utilizers	[gCOD/g of total COD]	0.0001	0.0001
FZba - Autotrophs	[gCOD/g of total COD]	0.0001	0.0001
FZbp - PAOs	[gCOD/g of total COD]	0.0001	0.0001
FZbpa - Propionic acetogens	[gCOD/g of total COD]	0.0001	0.0001
FZbam - Acetoclastic methanogens	[gCOD/g of total COD]	0.0001	0.0001
FZbhm - H2-utilizing methanogens	[gCOD/g of total COD]	0.0001	0.0001

## Configuration information for all Ideal clarifier units

### Physical data

Element name	Volume [Mil. Gal]	Area [ft <sup>2</sup> ]	Depth [ft]
Final clarifiers	0.7109	8640.0000	11.0

### Operating data Average (flow/time weighted as required)

Element name	Split type	Average Split specification
Final clarifiers	Flowrate [Under]	3596.14

Element name	Average Temperature	Reactive	Percent removal	Blanket fraction
Final clarifiers	Uses global setting	No	98.50	0.05

## Configuration information for all Effluent units

## Configuration information for all Sludge units

### BioWin Album

#### Album page - Influent

BOD Influent			
Parameters	Conc. (mg/L)	Mass rate (lb/d)	Notes
Volatile suspended solids	113.41	5110.84	
Total suspended solids	151.23	6815.19	
Particulate COD	181.43	8176.29	
Filtered COD	83.10	3744.83	
Total COD	264.53	11921.12	
Soluble PO4-P	7.25	326.72	
Total P	14.50	653.45	
Filtered TKN	17.54	790.41	
Particulate TKN	3.20	144.24	
Total Kjeldahl Nitrogen	20.74	934.65	
Filtered Carbonaceous BOD	49.35	2224.05	
Total Carbonaceous BOD	127.08	5726.88	
Total N	20.74	934.65	
Total inorganic N	15.56	700.99	
Alkalinity	1.33	27.08	mmol/L and kmol/d
pH	7.60		
Volatile fatty acids	7.94	357.63	
Total precipitated solids	0.00	0.00	
Total inorganic suspended solids	37.82	1704.35	
Ammonia N	15.56	700.99	
Nitrate N	0.00	0.00	
Parameters	Value	Units	
pH	7.60		
Ionized ammonium	15.34	mgN/L	
Unionized ammonia	0.21	mgN/L	
Total dissolved CO2	0.06	mmol/L	
Bicarbonate	1.06	mmol/L	

Carbonate	0.00	nmol/L
Unionized ortho-P	0.00	mgP/L
H <sub>2</sub> PO <sub>4</sub> <sup>-</sup>	1.59	mgP/L
HPO <sub>4</sub> <sup>2-</sup>	5.66	mgP/L
PO <sub>4</sub> <sup>3-</sup>	0.00	mgP/L
Metal phosphate (solid)	0.00	mgTSS/L
Metal hydroxide (solid)	0.00	mgTSS/L
Metal ion	0.00	mgMe/L
MeH <sub>2</sub> PO <sub>4</sub> <sup>++</sup>	0.00	mgMe/L
MeHPO <sub>4</sub> <sup>+</sup>	0.00	mgMe/L
Acetic acid	0.01	mg/L
Acetate	7.93	mg/L
Propionic acid	0.00	mg/L
Propionate	0.00	mg/L
Ionic strength	0.02	
Flow	5.40	mgd

### Album page - Aeration Tanks

Aeration Tanks			
Parameters	Conc. (mg/L)	Mass rate (lb/d)	Notes
Volatile suspended solids	602.42	32276.11	
Total suspended solids	986.84	52872.17	
Particulate COD	879.71	47132.70	
Filtered COD	16.14	864.98	
Total COD	895.86	47997.68	
Soluble PO <sub>4</sub> -P	8.53	456.84	
Total P	26.41	1414.93	
Filtered TKN	11.15	597.47	
Particulate TKN	54.50	2919.90	
Total Kjeldahl Nitrogen	65.65	3517.36	
Filtered Carbonaceous BOD	1.93	103.17	
Total Carbonaceous BOD	363.45	19472.54	
Total N	73.86	3957.41	
Total inorganic N	17.73	949.98	
Alkalinity	0.65	15.76	mmol/L and kmol/d
pH	6.10		
Volatile fatty acids	0.04	2.21	
Total precipitated solids	0.00	0.00	
Total inorganic suspended solids	384.42	20596.06	
Ammonia N	9.52	509.93	
Nitrate N	8.21	440.04	
Parameters	Value	Units	
Hydraulic residence time	4.4	hours	
Flow	6.42	mgd	
MLSS	986.84	mg/L	
Dissolved oxygen	2.00	mg/L	
Total readily biodegradable COD	2.50	mg/L	
Total oxygen uptake rate	20.75	mgO <sub>2</sub> /L/hr	
Carbonaceous OUR	13.38	mgO <sub>2</sub> /L/hr	
Nitrogenous OUR	7.37	mgO <sub>2</sub> /L/hr	
Nitrate uptake rate	0.10	mgN/L/hr	
Nitrification rate	1.70	mgN/L/hr	
Denitrification rate	0.10	mgN/L/hr	
Spec. denite rate per VSS	0.16	mgN/gVSS/hr	
Spec. denite rate per VASS	0.23	mgN/gVASS/hr	
Net Nitrate production rate	1.60	mgN/L/hr	
OTE	12.74	%	
OTR	208.28	lb/hr	
SOTE	39.50	%	
SOTR	631.14	lb/hr	
Air supply rate	1566.16	ft <sup>3</sup> /min (20C, 1 atm)	
Air flow rate / diffuser	0.69	ft <sup>3</sup> /min (20C, 1 atm)	
# of diffusers	2264.00		
Off gas flow rate (dry)	1552.61	ft <sup>3</sup> /min	
Oxygen content	18.56	%	
Carbon dioxide content	1.85	%	

Ammonia content	0.00	%
Actual DO sat. conc.	8.86	mg/L

### Album page - Effluent

Effluent			
Parameters	Conc. (mg/L)	Mass rate (lb/d)	Notes
Volatile suspended solids	10.61	484.14	
Total suspended solids	17.37	793.08	
Particulate COD	15.49	706.99	
Filtered COD	16.14	736.99	
Total COD	31.63	1443.98	
Soluble PO4-P	8.53	389.24	
Total P	8.84	403.61	
Filtered TKN	11.15	509.06	
Particulate TKN	0.96	43.80	
Total Kjeldahl Nitrogen	12.11	552.86	
Filtered Carbonaceous BOD	1.93	87.90	
Total Carbonaceous BOD	8.29	378.44	
Total N	20.32	927.78	
Total inorganic N	17.73	809.40	
Alkalinity	0.65	13.43	mmol/L and kmol/d
pH	6.10		
Volatile fatty acids	0.04	1.89	
Total precipitated solids	0.00	0.00	
Total inorganic suspended solids	6.77	308.94	
Ammonia N	9.52	434.47	
Nitrate N	8.21	374.93	
Parameters	Value	Units	
pH	6.10		
Ionized ammonium	9.51	mgN/L	
Unionized ammonia	0.00	mgN/L	
Total dissolved CO2	1.02	mmol/L	
Bicarbonate	0.62	mmol/L	
Carbonate	0.00	mmol/L	
Unionized ortho-P	0.00	mgP/L	
H2PO4-	7.63	mgP/L	
HPO4--	0.90	mgP/L	
PO4---	0.00	mgP/L	
Metal phosphate (solid)	0.00	mgTSS/L	
Metal hydroxide (solid)	0.00	mgTSS/L	
Metal ion	0.00	mgMe/L	
MeH2PO4++	0.00	mgMe/L	
MeHPO4+	0.00	mgMe/L	
Acetic acid	0.00	mg/L	
Acetate	0.04	mg/L	
Propionic acid	0.00	mg/L	
Propionate	0.00	mg/L	
Ionic strength	0.02		
Flow	5.47	mgd	

### Global Parameters

#### Autotroph

Name	Default	Value	
Max. spec. growth rate [1/d]	0.90000	0.90000	1.0720
Substrate (NH4) half sat. [mgN/L]	0.70000	0.70000	1.0000
Aerobic decay rate [1/d]	0.17000	0.17000	1.0290
Anoxic/anaerobic decay rate [1/d]	0.08000	0.08000	1.0290
CO2 half sat. for autotrophs [mmol/L]	0.01000	0.01000	1.0000

## Heterotroph

Name	Default	Value	
Max. spec. growth rate [1/d]	3.20000	3.20000	1.0290
Substrate half sat. [mgCOD/L]	5.00000	5.00000	1.0000
Anoxic growth factor [-]	0.50000	0.50000	1.0000
Aerobic decay [1/d]	0.62000	0.62000	1.0290
Anoxic/anaerobic decay [1/d]	0.30000	0.30000	1.0290
Hydrolysis rate (AS) [1/d]	2.10000	2.10000	1.0290
Hydrolysis half sat. (AS) [-]	0.06000	0.06000	1.0000
Anoxic hydrolysis factor [-]	0.28000	0.28000	1.0000
Anaerobic hydrolysis factor [-]	0.50000	0.50000	1.0000
Adsorption rate of colloids [L/(mgCOD d)]	0.80000	0.80000	1.0290
Ammonification rate [L/(mgN d)]	0.04000	0.04000	1.0290
Fermentation rate [1/d]	3.20000	3.20000	1.0290
Fermentation half sat. [mgCOD/L]	5.00000	5.00000	1.0000
Anaerobic growth factor (AS) [-]	0.12500	0.12500	1.0000
Hydrolysis rate (AD) [1/d]	0.10000	0.10000	1.0500
Hydrolysis half sat. (AD) [mgCOD/L]	0.15000	0.15000	1.0000

## Methanol utilizers

Name	Default	Value	
Max. spec. growth rate of methanol utilizers [1/d]	6.40000	6.40000	1.0290
Methanol half sat. [mgCOD/L]	0.50000	0.50000	1.0000
Aerobic decay rate of methanol utilizers [1/d]	0.24000	0.24000	1.0290
Anoxic/anaerobic decay rate of methanol utilizers [1/d]	0.12000	0.12000	1.0290

## PolyP

Name	Default	Value	
Max. spec. growth rate [1/d]	0.95000	0.95000	1.0000
Max. spec. growth rate, P-limited [1/d]	0.42000	0.42000	1.0000
Substrate half sat. [mgCOD/L]	0.10000	0.10000	1.0000
Substrate half sat., P-limited [mgCOD/L]	0.05000	0.05000	1.0000
Magnesium half sat. [mgMg/L]	0.10000	0.10000	1.0000
Cation half sat. [mmol/L]	0.10000	0.10000	1.0000
Calcium half sat. [mgCa/L]	0.10000	0.10000	1.0000
Aerobic decay rate [1/d]	0.10000	0.10000	1.0000
Anaerobic decay rate [1/d]	0.04000	0.04000	1.0000
Sequestration rate [1/d]	6.00000	6.00000	1.0000
Anoxic growth factor [-]	0.33000	0.33000	1.0000

## Propionic Acetogen

Name	Default	Value	
Max. spec. growth rate [1/d]	0.25000	0.25000	1.0290
Substrate half sat. [mgCOD/L]	10.00000	10.00000	1.0000
Acetate inhibition [mgCOD/L]	10000.00000	10000.00000	1.0000
Decay rate [1/d]	0.05000	0.05000	1.0290
Aerobic decay rate [1/d]	0.52000	0.52000	1.0290

## Methanogen

Name	Default	Value	
Acetoclastic Mu Max [1/d]	0.30000	0.30000	1.0290
H2-utilizing Mu Max [1/d]	1.40000	1.40000	1.0290
Acetoclastic Ks [mgCOD/L]	100.00000	100.00000	1.0000
H2-utilizing CO2 half sat. [mmol/L]	0.10000	0.10000	1.0000
H2-utilizing Ks [mgCOD/L]	0.10000	0.10000	1.0000
Acetoclastic propionic inhibition [mgCOD/L]	10000.00000	10000.00000	1.0000
Acetoclastic decay rate [1/d]	0.13000	0.13000	1.0290
Acetoclastic aerobic decay rate [1/d]	0.60000	0.60000	1.0290
H2-utilizing decay rate [1/d]	0.13000	0.13000	1.0290
H2-utilizing aerobic decay rate [1/d]	0.60000	0.60000	1.0290

## pH Inhibition

Name	Default	Value
Heterotrophs low pH limit [-]	4.00000	4.00000
Heterotrophs high pH limit [-]	10.00000	10.00000
Methanol utilizers low pH limit [-]	4.00000	4.00000
Methanol utilizers high pH limit [-]	10.00000	10.00000
Autotrophs low pH limit [-]	5.50000	5.50000
Autotrophs high pH limit [-]	9.50000	9.50000
PolyP heterotrophs low pH limit [-]	4.00000	4.00000
Poly P heterotrophs high pH limit [-]	10.00000	10.00000
Heterotrophs low pH limit (anaerobic) [-]	5.50000	5.50000
Heterotrophs high pH limit (anaerobic) [-]	8.50000	8.50000
Propionic acetogens low pH limit [-]	4.00000	4.00000
Propionic acetogens high pH limit [-]	10.00000	10.00000
Acetoclastic methanogens low pH limit [-]	5.50000	5.50000
Acetoclastic methanogens high pH limit [-]	8.50000	8.50000
H <sub>2</sub> -utilizing methanogens low pH limit [-]	5.50000	5.50000
H <sub>2</sub> -utilizing methanogens high pH limit [-]	8.50000	8.50000

## Switching Functions

Name	Default	Value
Heterotrophic DO limit [mgO <sub>2</sub> /L]	0.05000	0.05000
Aerobic denit. DO limit [mgO <sub>2</sub> /L]	0.05000	0.05000
Autotrophic DO limit [mgO <sub>2</sub> /L]	0.25000	0.25000
Anoxic NO <sub>3</sub> limit [mgN/L]	0.10000	0.10000
NH <sub>3</sub> nutrient limit [mgN/L]	0.00500	0.00500
NO <sub>3</sub> nutrient limit [mgN/L]	0.00500	0.00500
PolyP limit [mgP/L]	0.01000	0.01000
VFA sequestration limit [mgCOD/L]	5.00000	5.00000
P uptake limit [mgP/L]	0.15000	0.15000
P nutrient limit [mgP/L]	0.00500	0.00500
Heterotrophic Hydrogen limit [mgCOD/L]	1.00000	1.00000
Propionic acetogens Hydrogen limit [mgCOD/L]	5.00000	5.00000

## Autotroph

Name	Default	Value
Yield [mgCOD/mgN]	0.24000	0.24000
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in inert [mgP/mgCOD]	0.02200	0.02200
Fraction to endogenous residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

## Heterotroph

Name	Default	Value
Yield (aerobic) [-]	0.66600	0.66600
Yield (fermentation, low H <sub>2</sub> ) [-]	0.10000	0.10000
Yield (fermentation, high H <sub>2</sub> ) [-]	0.10000	0.10000
Yield (fermentation of methanol) [-]	0.10000	0.10000
H <sub>2</sub> yield (fermentation low H <sub>2</sub> ) [-]	0.35000	0.35000
H <sub>2</sub> yield (fermentation high H <sub>2</sub> ) [-]	0.0	0.0
H <sub>2</sub> yield (methanol fermentation) [-]	0.35000	0.35000
Propionate yield (fermentation, low H <sub>2</sub> ) [-]	0.0	0.0
Propionate yield (fermentation, high H <sub>2</sub> ) [-]	0.70000	0.70000
CO <sub>2</sub> yield (fermentation, low H <sub>2</sub> ) [-]	0.50000	0.50000
CO <sub>2</sub> yield (fermentation, high H <sub>2</sub> ) [-]	0.0	0.0
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in inert [mgP/mgCOD]	0.02200	0.02200
Endogenous Residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
Yield (anoxic) [-]	0.54000	0.54000
Yield propionic (aerobic) [-]	0.50000	0.50000

Yield propionic (anoxic) [-]	0.41000	0.41000
Yield acetic (aerobic) [-]	0.40000	0.40000
Yield acetic (anoxic) [-]	0.32000	0.32000
Yield methanol (aerobic) [-]	0.50000	0.50000
Adsorp. max. [-]	1.00000	1.00000

### Methanol utilizer

Name	Default	Value
Yield (anoxic) [-]	0.40000	0.40000
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in inert [mgP/mgCOD]	0.02200	0.02200
Endogenous Residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

### PolyP

Name	Default	Value
Yield (aerobic) [-]	0.63900	0.63900
Yield (anoxic) [-]	0.52000	0.52000
Aerobic P/PHA uptake [mgP/mgCOD]	0.95000	0.95000
Anoxic P/PHA uptake [mgP/mgCOD]	0.35000	0.35000
Yield of PHA on sequestration [-]	0.88900	0.88900
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in part. inert [mgN/mgCOD]	0.07000	0.07000
N in sol. inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in part. inert [mgP/mgCOD]	0.02200	0.02200
Fraction to endogenous part. [-]	0.25000	0.25000
Inert fraction of endogenous sol. [-]	0.20000	0.20000
P/Ac release ratio [mgP/mgCOD]	0.49000	0.49000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
Yield of low PP [-]	0.94000	0.94000

### Propionic Acetogen

Name	Default	Value
Yield [-]	0.10000	0.10000
H <sub>2</sub> yield [-]	0.40000	0.40000
CO <sub>2</sub> yield [-]	1.00000	1.00000
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in endogenous residue [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in endogenous residue [mgP/mgCOD]	0.02200	0.02200
Fraction to endogenous residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

### Methanogen

Name	Default	Value
Acetoclastic yield [-]	0.10000	0.10000
H <sub>2</sub> -utilizing yield [-]	0.10000	0.10000
N in acetoclastic biomass [mgN/mgCOD]	0.07000	0.07000
N in H <sub>2</sub> -utilizing biomass [mgN/mgCOD]	0.07000	0.07000
N in acetoclastic endog. residue [mgN/mgCOD]	0.07000	0.07000
N in H <sub>2</sub> -utilizing endog. residue [mgN/mgCOD]	0.07000	0.07000
P in acetoclastic biomass [mgP/mgCOD]	0.02200	0.02200
P in H <sub>2</sub> -utilizing biomass [mgP/mgCOD]	0.02200	0.02200
P in acetoclastic endog. residue [mgP/mgCOD]	0.02200	0.02200
P in H <sub>2</sub> -utilizing endog. residue [mgP/mgCOD]	0.02200	0.02200
Acetoclastic fraction to endog. residue [-]	0.08000	0.08000
H <sub>2</sub> -utilizing fraction to endog. residue [-]	0.08000	0.08000
Acetoclastic COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
H <sub>2</sub> -utilizing COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

## General

Name	Default	Value
Particulate substrate COD:VSS ratio [mgCOD/mgVSS]	1.60000	1.60000
Particulate inert COD:VSS ratio [mgCOD/mgVSS]	1.60000	1.60000
Ash content of biomass (synthesis ISS) [%]	8.00000	8.00000
Molecular weight of other anions [mg/mmol]	35.50000	35.50000
Molecular weight of other cations [mg/mmol]	39.10000	39.10000
Mg to P mole ratio in polyphosphate [mmolMg/mmolP]	0.30000	0.30000
Cation to P mole ratio in polyphosphate [meq/mmolP]	0.30000	0.30000
Ca to P mole ratio in polyphosphate [mmolCa/mmolP]	0.05000	0.05000
Cation to P mole ratio in organic phosphate [meq/mmolP]	0.01000	0.01000
Bubble rise velocity (anaerobic digester) [cm/s]	23.90000	23.90000
Bubble Sauter mean diameter (anaerobic digester) [cm]	0.35000	0.35000

## Mass transfer

Name	Default	Value
K <sub>L</sub> for H <sub>2</sub> [m/d]	17.00000	17.00000
K <sub>L</sub> for CO <sub>2</sub> [m/d]	10.00000	10.00000
K <sub>L</sub> for NH <sub>3</sub> [m/d]	1.00000	1.00000

## Physico-chemical rates

Name	Default	Value
Struvite precipitation rate [1/d]	3.0000E+10	3.0000E+10
Struvite redissolution rate [1/d]	3.0000E+11	3.0000E+11
Struvite half sat. [mgTSS/L]	1.00000	1.00000
HDP precipitation rate [L/(mol P d)]	1.0000E+8	1.0000E+8
HDP redissolution rate [L/(mol P d)]	1.0000E+8	1.0000E+8
HAP precipitation rate [molHDP/(L d)]	5.0000E-4	5.0000E-4

## Physico-chemical constants

Name	Default	Value
Struvite solubility constant [mol/L]	6.9180E-14	6.9180E-14
HDP solubility product [mol/L]	2.7500E-22	2.7500E-22
HDP half sat. [mgTSS/L]	1.00000	1.00000
Equilibrium soluble PO <sub>4</sub> with Al dosing at pH 7 [mgP/L]	0.01000	0.01000
Al to P ratio [molAl/molP]	0.80000	0.80000
Al(OH) <sub>3</sub> solubility product [mol/L]	1.2590E+9	1.2590E+9
AlHPO <sub>4</sub> dissociation constant [mol/L]	7.9430E-13	7.9430E-13
Equilibrium soluble PO <sub>4</sub> with Fe dosing at pH 7 [mgP/L]	0.01000	0.01000
Fe to P ratio [molFe/molP]	1.60000	1.60000
Fe(OH) <sub>3</sub> solubility product [mol/L]	0.05000	0.05000
FeH <sub>2</sub> PO <sub>4</sub> ++ dissociation constant [mol/L]	5.0120E-22	5.0120E-22

## Aeration

Name	Default	Value
Alpha (surf) OR Alpha F (diff) [-]	0.50000	0.50000
Beta [-]	0.95000	0.95000
Surface pressure [kPa]	101.32500	101.32500
Fractional effective saturation depth (Fed) [-]	0.32500	0.32500
Supply gas CO <sub>2</sub> content [vol. %]	0.03500	0.03500
Supply gas O <sub>2</sub> [vol. %]	20.95000	20.95000
Off-gas CO <sub>2</sub> [vol. %]	2.00000	2.00000
Off-gas O <sub>2</sub> [vol. %]	18.80000	18.80000
Off-gas H <sub>2</sub> [vol. %]	0.0	0.0
Off-gas NH <sub>3</sub> [vol. %]	0.0	0.0
Surface turbulence factor [-]	0.25000	0.25000
Set point controller gain [1]	1.00000	1.00000

### Modified Vesilind

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [ft/min]	0.3873	0.3873
Vesilind hindered zone settling parameter (K) [L/g]	0.3700	0.3700
Clarification switching function [mg/L]	100.0000	100.0000
Specified TSS conc. for height calc. [mg/L]	2500.0000	2500.0000
Maximum compactability constant [mg/L]	15000.0000	15000.0000

### Double exponential

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [ft/min]	0.9341	0.9341
Maximum (practical) settling velocity (Vo') [ft/min]	0.6152	0.6152
Hindered zone settling parameter (Kh) [L/g]	0.4000	0.4000
Flocculent zone settling parameter (Kf) [L/g]	2.5000	2.5000
Maximum non-settleable TSS [mg/L]	20.0000	20.0000
Non-settleable fraction [-]	0.0010	0.0010
Specified TSS conc. for height calc. [mg/L]	2500.0000	2500.0000

## BioWin user and configuration data

### Project details

Project name: Future Conditions - Phase 4  
Plant name: Kingston

Project ref.: 5744001  
User name: MARPICATI

Created: 5/23/2006

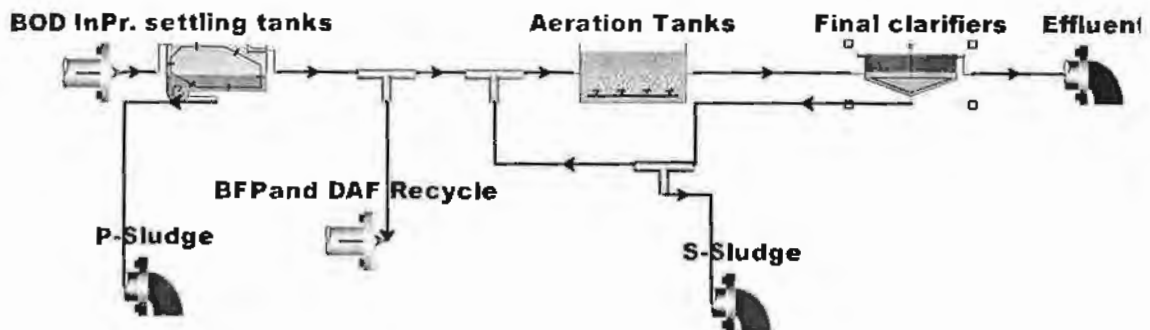
Saved: 8/12/2008

### Steady state solution

SRT #0: 2.37

Temperature: 20.0

### Flowsheet



## Configuration information for all Ideal primary settling tank units

### Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Pr. settling tanks	0.4625	5472.0000	11.3

### Operating data Average (flow/time weighted as required)

Element name	Split type	Average Split specification
Pr. settling tanks	Flowrate [Under]	0.18

Element name	Percent removal	Blanket fraction
Pr. settling tanks	60.00	0.10

## Configuration information for all Bioreactor units

### Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Aeration Tanks	1.1807	9990.0000	15.8	2264

### Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint
Aeration Tanks	2.0

### Aeration equipment parameters

Element name	$k1 \text{ in } C = k1(PC)^{0.25} + k2$	$k2 \text{ in } C = k1(PC)^{0.25} + k2$	$Y \text{ in } K1a = C \text{ Usg}^{\wedge} Y - Usg \text{ in } [m3/(m2 \cdot d)]$	Area of one diffuser	% of tank area covered by diffusers [%]
Aeration Tanks	2.5656	0.0432	0.8200	0.0410	10.0000

### Configuration information for all Sidestream Mixer units

#### Physical data

Element name	Volume[Mil. Gal]	Area[ft2]	Depth[ft]
Sidestream Mixer7	0	N/A	N/A
Sidestream Mixer10	0	N/A	N/A

### Configuration information for all Splitter units

#### Physical data

Element name	Volume[Mil. Gal]	Area[ft2]	Depth[ft]
Splitter4	0	N/A	N/A

### Operating data Average (flow/time weighted as required)

Element name	Split type	Average Split specification
Splitter4	Flowrate [Side]	0.065

### Configuration information for all BOD Influent units

#### Operating data Average (flow/time weighted as required)

Element name	BOD Influent	BFPand DAF Recycle
Flow	6.3481	0.337
Total Carbonaceous BOD mg/L	138.42	171.00
Volatile suspended solids mg/L	123.35	118.80
Total suspended solids mgTSS/L	164.47	444.40
Total Kjeldahl Nitrogen mgN/L	22.02	135.20
Total P mgP/L	13.80	10.00
Nitrate N mgN/L	0.00	0.00
pH	7.60	7.30
Alkalinity mmol/L	1.33	12.00
Calcium mg/L	160.00	160.00
Magnesium mg/L	25.00	25.00
Dissolved oxygen mg/L	0.00	0.00

Element name	BOD Influent	BFPand DAF Recycle
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.2000	0.2000
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1500	0.1500
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.8952	0.6916
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0500	0.0500
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300	0.1300
Fna - Ammonia [gNH3-N/gTKN]	0.7500	0.6600
Foos - Particulate organic nitrogen [gN/g Organic N]	0.5000	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0000	0.0000
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0350	0.0350
Fpo4 - Phosphate [gPO4-P/gTPP]	0.5000	0.5000
FupP - P:COD ratio for influent unbiodegradable part. COD [gP/gCOD]	0.0110	0.0110

FZbh - Non-poly-P heterotrophs	[gCOD/g of total COD]	0.0001	0.0001
FZbm - Anoxic methanol utilizers	[gCOD/g of total COD]	0.0001	0.0001
FZba - Autotrophs	[gCOD/g of total COD]	0.0001	0.0001
FZbp - PAOs	[gCOD/g of total COD]	0.0001	0.0001
FZbpa - Propionic acetogens	[gCOD/g of total COD]	0.0001	0.0001
FZham - Acetoclastic methanogens	[gCOD/g of total COD]	0.0001	0.0001
FZbhm - H <sub>2</sub> -utilizing methanogens	[gCOD/g of total COD]	0.0001	0.0001

## Configuration information for all Ideal clarifier units

### Physical data

Element name	Volume [Mil. Gal]	Area [ft <sup>2</sup> ]	Depth [ft]
Final clarifiers	0.7109	8640.0000	11.0

### Operating data Average (flow/time weighted as required)

Element name	Split type	Average Split specification
Final clarifiers	Flowrate [Under]	3596.14

Element name	Average Temperature	Reactive	Percent removal	Blanket fraction
Final clarifiers	Uses global setting	No	98.40	0.05

## Configuration information for all Effluent units

## Configuration information for all Sludge units

### BioWin Album

#### Album page - Influent

BOD Influent			
Parameters	Conc. (mg/L)	Mass rate (lb/d)	Notes
Volatile suspended solids	123.35	6534.77	
Total suspended solids	164.49	8714.34	
Particulate COD	197.33	10454.28	
Filtered COD	90.72	4805.93	
Total COD	288.05	15260.21	
Soluble PO4-P	6.90	365.54	
Total P	13.80	731.09	
Filtered TKN	18.61	985.65	
Particulate TKN	3.41	180.91	
Total Kjeldahl Nitrogen	22.02	1166.56	
Filtered Carbonaceous BOD	53.90	2855.61	
Total Carbonaceous BOD	138.42	7333.14	
Total N	22.02	1166.56	
Total inorganic N	16.52	874.92	
Alkalinity	1.33	31.84	mmol/L and kmol/d
pH	7.60		
Volatile fatty acids	8.64	457.81	
Total precipitated solids	0.00	0.00	
Total inorganic suspended solids	41.14	2179.57	
Ammonia N	16.52	874.92	
Nitrate N	0.00	0.00	
Parameters	Value	Units	
pH	7.60		
Ionized ammonium	16.29	mgN/L	
Unionized ammonia	0.23	mgN/L	
Total dissolved CO2	0.06	mmol/L	
Bicarbonate	1.06	mmol/L	

Carbonate	0.00	mmol/L
Unionized ortho-P	0.00	mgP/L
H <sub>2</sub> PO <sub>4</sub> <sup>-</sup>	1.51	mgP/L
HPO <sub>4</sub> <sup>2-</sup>	5.39	mgP/L
PO <sub>4</sub> <sup>3-</sup>	0.00	mgP/L
Metal phosphate (solid)	0.00	mgTSS/L
Metal hydroxide (solid)	0.00	mgTSS/L
Metal ion	0.00	mgMe/L
MeH <sub>2</sub> PO <sub>4</sub> <sup>++</sup>	0.00	mgMe/L
MeHPO <sub>4</sub> <sup>+</sup>	0.00	mgMe/L
Acetic acid	0.01	mg/L
Acetate	8.63	mg/L
Propionic acid	0.00	mg/L
Propionate	0.00	mg/L
Ionic strength	0.02	
Flow	6.35	mgd

### Album page - Aeration Tanks

Aeration Tanks			
Parameters	Conc. (mg/L)	Mass rate (lb/d)	Notes
Volatile suspended solids	666.79	41123.19	
Total suspended solids	1059.40	65336.50	
Particulate COD	974.11	60076.41	
Filtered COD	17.55	1082.10	
Total COD	991.65	61158.51	
Soluble PO <sub>4</sub> -P	7.88	486.03	
Total P	27.67	1706.48	
Filtered TKN	15.23	939.47	
Particulate TKN	60.17	3711.01	
Total Kjeldahl Nitrogen	75.41	4650.48	
Filtered Carbonaceous BOD	2.12	130.98	
Total Carbonaceous BOD	410.14	25294.84	
Total N	79.94	4929.95	
Total inorganic N	18.11	1116.86	
Alkalinity	1.10	30.91	mmol/L and kmol/d
pH	6.34		
Volatile fatty acids	0.05	2.87	
Total precipitated solids	0.00	0.00	
Total inorganic suspended solids	392.61	24213.31	
Ammonia N	13.58	837.39	
Nitrate N	4.53	279.47	
Parameters	Value	Units	
Hydraulic residence time	3.8	hours	
Flow	7.39	mgd	
MLSS	1059.40	mg/L	
Dissolved oxygen	2.00	mg/L	
Total readily biodegradable COD	2.75	mg/L	
Total oxygen uptake rate	21.23	mgO <sub>2</sub> /L/hr	
Carbonaceous OUR	16.21	mgO <sub>2</sub> /L/hr	
Nitrogenous OUR	5.01	mgO <sub>2</sub> /L/hr	
Nitrate uptake rate	0.12	mgN/L/hr	
Nitrification rate	1.16	mgN/L/hr	
Denitrification rate	0.12	mgN/L/hr	
Spec. denite rate per VSS	0.17	mgN/g VSS/hr	
Spec. denite rate per VASS	0.25	mgN/g VASS/hr	
Net Nitrate production rate	1.04	mgN/L/hr	
OTE	12.67	%	
OTR	213.68	lb/hr	
SOTE	39.27	%	
SOTR	647.52	lb/hr	
Air supply rate	1615.85	ft <sup>3</sup> /min (20C, 1 atm)	
Air flow rate / diffuser	0.71	ft <sup>3</sup> /min (20C, 1 atm)	
# of diffusers	2264.00		
Off gas flow rate (dry)	1600.48	ft <sup>3</sup> /min	
Oxygen content	18.61	%	
Carbon dioxide content	1.75	%	

Ammonia content	0.00	%
Actual DO sat. conc.	8.86	mg/L

### Album page - Effluent

Effluent			
Parameters	Conc. (mg/L)	Mass rate (lb/d)	Notes
Volatile suspended solids	12.24	657.97	
Total suspended solids	19.45	1045.38	
Particulate COD	17.88	961.22	
Filtered COD	17.55	943.00	
Total COD	35.43	1904.22	
Soluble PO4-P	7.88	423.55	
Total P	8.24	443.08	
Filtered TKN	15.23	818.70	
Particulate TKN	1.10	59.38	
Total Kjeldahl Nitrogen	16.34	878.08	
Filtered Carbonaceous BOD	2.12	114.14	
Total Carbonaceous BOD	9.62	516.76	
Total N	20.87	1121.62	
Total inorganic N	18.11	973.29	
Alkalinity	1.10	26.94	mmol/L and kmol/d
pH	6.34		
Volatile fatty acids	0.05	2.50	
Total precipitated solids	0.00	0.00	
Total inorganic suspended solids	7.21	387.41	
Ammonia N	13.58	729.74	
Nitrate N	4.53	243.55	
Parameters	Value	Units	
pH	6.34		
Ionized ammonium	13.57	mgN/L	
Unionized ammonia	0.01	mgN/L	
Total dissolved CO2	1.01	mmol/L	
Bicarbonate	1.06	mmol/L	
Carbonate	0.00	mmol/L	
Unionized ortho-P	0.00	mgP/L	
H2PO4-	6.54	mgP/L	
HPO4--	1.34	mgP/L	
PO4---	0.00	mgP/L	
Metal phosphate (solid)	0.00	mgTSS/L	
Metal hydroxide (solid)	0.00	mgTSS/L	
Metal ion	0.00	mgMe/L	
MeH2PO4++	0.00	mgMe/L	
MeHPO4+	0.00	mgMe/L	
Acetic acid	0.00	mg/L	
Acetate	0.05	mg/L	
Propionic acid	0.00	mg/L	
Propionate	0.00	mg/L	
Ionic strength	0.02		
Flow	6.44	mgd	

### Global Parameters

#### Autotroph

Name	Default	Value	
Max. spec. growth rate [1/d]	0.90000	0.90000	1.0720
Substrate (NH4) half sat. [mgN/L]	0.70000	0.70000	1.0000
Aerobic decay rate [1/d]	0.17000	0.17000	1.0290
Anoxic/anaerobic decay rate [1/d]	0.08000	0.08000	1.0290
CO2 half sat. for autotrophs [mmol/L]	0.01000	0.01000	1.0000

## Heterotroph

Name	Default	Value	
Max. spec. growth rate [1/d]	3.20000	3.20000	1.0290
Substrate half sat. [mgCOD/L]	5.00000	5.00000	1.0000
Anoxic growth factor [-]	0.50000	0.50000	1.0000
Aerobic decay [1/d]	0.62000	0.62000	1.0290
Anoxic/anaerobic decay [1/d]	0.30000	0.30000	1.0290
Hydrolysis rate (AS) [1/d]	2.10000	2.10000	1.0290
Hydrolysis half sat. (AS) [-]	0.06000	0.06000	1.0000
Anoxic hydrolysis factor [-]	0.28000	0.28000	1.0000
Anaerobic hydrolysis factor [-]	0.50000	0.50000	1.0000
Adsorption rate of colloids [L/(mgCOD d)]	0.80000	0.80000	1.0290
Ammonification rate [L/(mgN d)]	0.04000	0.04000	1.0290
Fermentation rate [1/d]	3.20000	3.20000	1.0290
Fermentation half sat. [mgCOD/L]	5.00000	5.00000	1.0000
Anaerobic growth factor (AS) [-]	0.12500	0.12500	1.0000
Hydrolysis rate (AD) [1/d]	0.10000	0.10000	1.0500
Hydrolysis half sat. (AD) [mgCOD/L]	0.15000	0.15000	1.0000

## Methanol utilizers

Name	Default	Value	
Max. spec. growth rate of methanol utilizers [1/d]	6.40000	6.40000	1.0290
Methanol half sat. [mgCOD/L]	0.50000	0.50000	1.0000
Aerobic decay rate of methanol utilizers [1/d]	0.24000	0.24000	1.0290
Anoxic/anaerobic decay rate of methanol utilizers [1/d]	0.12000	0.12000	1.0290

## PolyP

Name	Default	Value	
Max. spec. growth rate [1/d]	0.95000	0.95000	1.0000
Max. spec. growth rate, P-limited [1/d]	0.42000	0.42000	1.0000
Substrate half sat. [mgCOD/L]	0.10000	0.10000	1.0000
Substrate half sat., P-limited [mgCOD/L]	0.05000	0.05000	1.0000
Magnesium half sat. [mgMg/L]	0.10000	0.10000	1.0000
Cation half sat. [mmol/L]	0.10000	0.10000	1.0000
Calcium half sat. [mgCa/L]	0.10000	0.10000	1.0000
Aerobic decay rate [1/d]	0.10000	0.10000	1.0000
Anaerobic decay rate [1/d]	0.04000	0.04000	1.0000
Sequestration rate [1/d]	6.00000	6.00000	1.0000
Anoxic growth factor [-]	0.33000	0.33000	1.0000

## Propionic Acetogen

Name	Default	Value	
Max. spec. growth rate [1/d]	0.25000	0.25000	1.0290
Substrate half sat. [mgCOD/L]	10.00000	10.00000	1.0000
Acetate inhibition [mgCOD/L]	10000.00000	10000.00000	1.0000
Decay rate [1/d]	0.05000	0.05000	1.0290
Aerobic decay rate [1/d]	0.52000	0.52000	1.0290

## Methanogen

Name	Default	Value	
Acetoclastic Mu Max [1/d]	0.30000	0.30000	1.0290
H2-utilizing Mu Max [1/d]	1.40000	1.40000	1.0290
Acetoclastic Ks [mgCOD/L]	100.00000	100.00000	1.0000
H2-utilizing CO2 half sat. [mmol/L]	0.10000	0.10000	1.0000
H2-utilizing Ks [mgCOD/L]	0.10000	0.10000	1.0000
Acetoclastic propionic inhibition [mgCOD/L]	10000.00000	10000.00000	1.0000
Acetoclastic decay rate [1/d]	0.13000	0.13000	1.0290
Acetoclastic aerobic decay rate [1/d]	0.60000	0.60000	1.0290
H2-utilizing decay rate [1/d]	0.13000	0.13000	1.0290
H2-utilizing aerobic decay rate [1/d]	0.60000	0.60000	1.0290

## pH Inhibition

Name	Default	Value
Heterotrophs low pH limit [-]	4.00000	4.00000
Heterotrophs high pH limit [-]	10.00000	10.00000
Methanol utilizers low pH limit [-]	4.00000	4.00000
Methanol utilizers high pH limit [-]	10.00000	10.00000
Autotrophs low pH limit [-]	5.50000	5.50000
Autotrophs high pH limit [-]	9.50000	9.50000
PolyP heterotrophs low pH limit [-]	4.00000	4.00000
Poly P heterotrophs high pH limit [-]	10.00000	10.00000
Heterotrophs low pH limit (anaerobic) [-]	5.50000	5.50000
Heterotrophs high pH limit (anaerobic) [-]	8.50000	8.50000
Propionic acetogens low pH limit [-]	4.00000	4.00000
Propionic acetogens high pH limit [-]	10.00000	10.00000
Acetoclastic methanogens low pH limit [-]	5.50000	5.50000
Acetoclastic methanogens high pH limit [-]	8.50000	8.50000
H <sub>2</sub> -utilizing methanogens low pH limit [-]	5.50000	5.50000
H <sub>2</sub> -utilizing methanogens high pH limit [-]	8.50000	8.50000

## Switching Functions

Name	Default	Value
Heterotrophic DO limit [mgO <sub>2</sub> /L]	0.05000	0.05000
Aerobic denit. DO limit [mgO <sub>2</sub> /L]	0.05000	0.05000
Autotrophic DO limit [mgO <sub>2</sub> /L]	0.25000	0.25000
Anoxic NO <sub>3</sub> limit [mgN/L]	0.10000	0.10000
NH <sub>3</sub> nutrient limit [mgN/L]	0.00500	0.00500
NO <sub>3</sub> nutrient limit [mgN/L]	0.00500	0.00500
PolyP limit [mgP/L]	0.01000	0.01000
VFA sequestration limit [mgCOD/L]	5.00000	5.00000
P uptake limit [mgP/L]	0.15000	0.15000
P nutrient limit [mgP/L]	0.00500	0.00500
Heterotrophic Hydrogen limit [mgCOD/L]	1.00000	1.00000
Propionic acetogens Hydrogen limit [mgCOD/L]	5.00000	5.00000

## Autotroph

Name	Default	Value
Yield [mgCOD/mgN]	0.24000	0.24000
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in inert [mgP/mgCOD]	0.02200	0.02200
Fraction to endogenous residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

## Heterotroph

Name	Default	Value
Yield (aerobic) [-]	0.66600	0.66600
Yield (fermentation, low H <sub>2</sub> ) [-]	0.10000	0.10000
Yield (fermentation, high H <sub>2</sub> ) [-]	0.10000	0.10000
Yield (fermentation of methanol) [-]	0.10000	0.10000
H <sub>2</sub> yield (fermentation low H <sub>2</sub> ) [-]	0.35000	0.35000
H <sub>2</sub> yield (fermentation high H <sub>2</sub> ) [-]	0.0	0.0
H <sub>2</sub> yield (methanol fermentation) [-]	0.35000	0.35000
Propionate yield (fermentation, low H <sub>2</sub> ) [-]	0.0	0.0
Propionate yield (fermentation, high H <sub>2</sub> ) [-]	0.70000	0.70000
CO <sub>2</sub> yield (fermentation, low H <sub>2</sub> ) [-]	0.50000	0.50000
CO <sub>2</sub> yield (fermentation, high H <sub>2</sub> ) [-]	0.0	0.0
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in inert [mgP/mgCOD]	0.02200	0.02200
Endogenous Residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
Yield (anoxic) [-]	0.54000	0.54000
Yield propionic (aerobic) [-]	0.50000	0.50000

Yield propionic (anoxic) [-]	0.41000	0.41000
Yield acetic (aerobic) [-]	0.40000	0.40000
Yield acetic (anoxic) [-]	0.32000	0.32000
Yield methanol (aerobic) [-]	0.50000	0.50000
Adsorp. max. [-]	1.00000	1.00000

### Methanol utilizer

Name	Default	Value
Yield (anoxic) [-]	0.40000	0.40000
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in inert [mgP/mgCOD]	0.02200	0.02200
Endogenous Residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

### PolyP

Name	Default	Value
Yield (aerobic) [-]	0.63900	0.63900
Yield (anoxic) [-]	0.52000	0.52000
Aerobic P/PHA uptake [mgP/mgCOD]	0.95000	0.95000
Anoxic P/PHA uptake [mgP/mgCOD]	0.35000	0.35000
Yield of PHA on sequestration [-]	0.88900	0.88900
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in part. inert [mgN/mgCOD]	0.07000	0.07000
N in sol. inct [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in part. inert [mgP/mgCOD]	0.02200	0.02200
Fraction to endogenous part. [-]	0.25000	0.25000
Inert fraction of endogenous sol. [-]	0.20000	0.20000
P/Ac release ratio [mgP/mgCOD]	0.49000	0.49000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
Yield of low PP [-]	0.94000	0.94000

### Propionic Acetogen

Name	Default	Value
Yield [-]	0.10000	0.10000
H2 yield [-]	0.40000	0.40000
CO2 yield [-]	1.00000	1.00000
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in endogenous residue [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in endogenous residue [mgP/mgCOD]	0.02200	0.02200
Fraction to endogenous residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

### Methanogen

Name	Default	Value
Acetoclastic yield [-]	0.10000	0.10000
H2-utilizing yield [-]	0.10000	0.10000
N in acetoclastic biomass [mgN/mgCOD]	0.07000	0.07000
N in H2-utilizing biomass [mgN/mgCOD]	0.07000	0.07000
N in acetoclastic endog. residue [mgN/mgCOD]	0.07000	0.07000
N in H2-utilizing endog. residue [mgN/mgCOD]	0.07000	0.07000
P in acetoclastic biomass [mgP/mgCOD]	0.02200	0.02200
P in H2-utilizing biomass [mgP/mgCOD]	0.02200	0.02200
P in acetoclastic endog. residue [mgP/mgCOD]	0.02200	0.02200
P in H2-utilizing endog. residue [mgP/mgCOD]	0.02200	0.02200
Acetoclastic fraction to endog. residue [-]	0.08000	0.08000
H2-utilizing fraction to endog. residue [-]	0.08000	0.08000
Acetoclastic COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
H2-utilizing COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

## General

Name	Default	Value
Particulate substrate COD:VSS ratio [mgCOD/mgVSS]	1.60000	1.60000
Particulate inert COD:VSS ratio [mgCOD/mgVSS]	1.60000	1.60000
Ash content of biomass (synthesis ISS) [%]	8.00000	8.00000
Molecular weight of other anions [mg/mmol]	35.50000	35.50000
Molecular weight of other cations [mg/mmol]	39.10000	39.10000
Mg to P mole ratio in polyphosphate [mmolMg/mmolP]	0.30000	0.30000
Cation to P mole ratio in polyphosphate [meq/mmolP]	0.30000	0.30000
Ca to P mole ratio in polyphosphate [mmolCa/mmolP]	0.05000	0.05000
Cation to P mole ratio in organic phosphate [meq/mmolP]	0.01000	0.01000
Bubble rise velocity (anaerobic digester) [cm/s]	23.90000	23.90000
Bubble Sauter mean diameter (anaerobic digester) [cm]	0.35000	0.35000

## Mass transfer

Name	Default	Value
Kl for H2 [m/d]	17.00000	17.00000
Kl for CO2 [m/d]	10.00000	10.00000
Kl for NH3 [m/d]	1.00000	1.00000

## Physico-chemical rates

Name	Default	Value
Struvite precipitation rate [1/d]	3.0000E+10	3.0000E+10
Struvite redissolution rate [1/d]	3.0000E+11	3.0000E+11
Struvite half sat. [mgTSS/L]	1.00000	1.00000
HDP precipitation rate [L/(molP d)]	1.0000E+8	1.0000E+8
HDP redissolution rate [L/(molP d)]	1.0000E+8	1.0000E+8
HAP precipitation rate [molHDP/(L d)]	5.0000E-4	5.0000E-4

## Physico-chemical constants

Name	Default	Value
Struvite solubility constant [mol/L]	6.9180E-14	6.9180E-14
HDP solubility product [mol/L]	2.7500E-22	2.7500E-22
HDP half sat. [mgTSS/L]	1.00000	1.00000
Equilibrium soluble PO4 with Al dosing at pH 7 [mgP/L]	0.01000	0.01000
Al to P ratio [molAl/molP]	0.80000	0.80000
Al(OH)3 solubility product [mol/L]	1.2590E+9	1.2590E+9
AlHPO4+ dissociation constant [mol/L]	7.9430E-13	7.9430E-13
Equilibrium soluble PO4 with Fe dosing at pH 7 [mgP/L]	0.01000	0.01000
Fe to P ratio [molFe/molP]	1.60000	1.60000
Fe(OH)3 solubility product [mol/L]	0.05000	0.05000
FeH2PO4++ dissociation constant [mol/L]	5.0120E-22	5.0120E-22

## Aeration

Name	Default	Value
Alpha (surf) OR Alpha F (diff) [-]	0.50000	0.50000
Beta [-]	0.95000	0.95000
Surface pressure [kPa]	101.32500	101.32500
Fractional effective saturation depth (Fed) [-]	0.32500	0.32500
Supply gas CO2 content [vol. %]	0.03500	0.03500
Supply gas O2 [vol. %]	20.95000	20.95000
Off-gas CO2 [vol. %]	2.00000	2.00000
Off-gas O2 [vol. %]	18.80000	18.80000
Off-gas H2 [vol. %]	0.0	0.0
Off-gas NH3 [vol. %]	0.0	0.0
Surface turbulence factor [-]	0.25000	0.25000
Set point controller gain [-]	1.00000	1.00000

### Modified Vesilind

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [ft/min]	0.3873	0.3873
Vesilind hindered zone settling parameter (K) [L/g]	0.3700	0.3700
Clarification switching function [mg/L]	100.0000	100.0000
Specified TSS conc. for height calc. [mg/L]	2500.0000	2500.0000
Maximum compactability constant [mg/L]	15000.0000	15000.0000

### Double exponential

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [ft/min]	0.9341	0.9341
Maximum (practical) settling velocity (Vo') [ft/min]	0.6152	0.6152
Hindered zone settling parameter (Kh) [L/g]	0.4000	0.4000
Flocculent zone settling parameter (Kf) [L/g]	2.5000	2.5000
Maximum non-settleable TSS [mg/L]	20.0000	20.0000
Non-settleable fraction [-]	0.0010	0.0010
Specified TSS conc. for height calc. [mg/L]	2500.0000	2500.0000

## BioWin user and configuration data

### Project details

Project name: Future Conditions - Phase 5

Plant name: Kingston

Project ref.: 5744001

User name: MARPICATI

Created: 5/23/2006

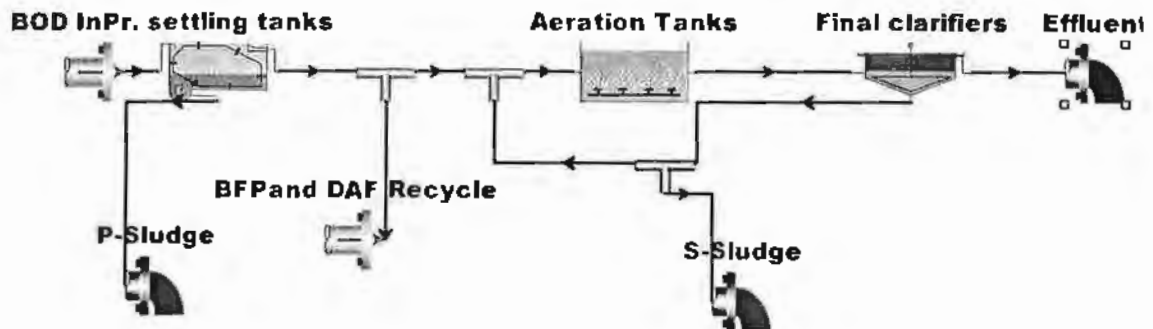
Saved: 8/12/2008

Steady state solution

SRT: 2.35

Temperature: 20.0

### Flowsheet



## Configuration information for all Ideal primary settling tank units

### Physical data

Element name	Volume [Mil. Gal]	Area [ft <sup>2</sup> ]	Depth [ft]
Pr. settling tanks	0.4625	5472.0000	11.3

### Operating data Average (flow/time weighted as required)

Element name	Split type	Average Split specification
Pr. settling tanks	Flowrate [Under]	0.18

Element name	Percent removal	Blanket fraction
Pr. settling tanks	60.00	0.10

## Configuration information for all Bioreactor units

### Physical data

Element name	Volume [Mil. Gal]	Area [ft <sup>2</sup> ]	Depth [ft]	# of diffusers
Aeration Tanks	1.1807	9990.0000	15.8	2264

### Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint
Aeration Tanks	2.0

### Aeration equipment parameters

Element name	$k_1$ in C = $k_1(PC)^{0.25} + k_2$	$k_2$ in C = $k_1(PC)^{0.25} + k_2$	Y in $Kla = C Usg^A$ Y - Usg in $[m^3/(m^2 d)]$	Area of one diffuser	% of tank area covered by diffusers [%]
Aeration Tanks	2.5656	0.0432	0.8200	0.0410	10.0000

## Configuration information for all Sidestream Mixer units

### Physical data

Element name	Volume[Mil. Gal]	Area[ft <sup>2</sup> ]	Depth[ft]
Sidestream Mixer7	0	N/A	N/A
Sidestream Mixer10	0	N/A	N/A

## Configuration information for all Splitter units

### Physical data

Element name	Volume[Mil. Gal]	Area[ft <sup>2</sup> ]	Depth[ft]
Splitter4	0	N/A	N/A

### Operating data Average (flow/time weighted as required)

Element name	Split type	Average Split specification
Splitter4	Flowrate [Side]	0.065

## Configuration information for all BOD Influent units

### Operating data Average (flow/time weighted as required)

Element name	BOD Influent	BFPand DAF Recycle
Flow	6.4036	0.34
Total Carbonaceous BOD mg/L	138.98	171.50
Volatile suspended solids mg/L	123.84	119.10
Total suspended solids mgTSS/L	165.13	445.60
Total Kjeldahl Nitrogen mgN/L	22.08	135.50
Total P mgP/L	13.70	10.00
Nitrate N mgN/L	0.00	0.00
pH	7.60	7.30
Alkalinity nmol/L	1.33	12.00
Calcium mg/L	160.00	160.00
Magnesium mg/L	25.00	25.00
Dissolved oxygen mg/L	0.00	0.00

Element name	BOD Influent	BFPand DAF Recycle
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.2000	0.2000
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1500	0.1500
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.8951	0.6913
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0500	0.0500
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300	0.1300
Fna - Ammonia [gNH3-N/gTKN]	0.7500	0.6600
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.5000	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0000	0.0000
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0350	0.0350
Fpo4 - Phosphate [gPO4-P/gTP]	0.5000	0.5000
FupP - P:COD ratio for influent unbiodegradable part. COD [gP/gCOD]	0.0110	0.0110

FZbh - Non-poly-P heterotrophs	[gCOD/g of total COD]	0.0001	0.0001
FZbm - Anoxic methanol utilizers	[gCOD/g of total COD]	0.0001	0.0001
FZba - Autotrophs	[gCOD/g of total COD]	0.0001	0.0001
FZbp - PAOs	[gCOD/g of total COD]	0.0001	0.0001
FZbpa - Propionic acetogens	[gCOD/g of total COD]	0.0001	0.0001
FZbam - Acetoclastic methanogens	[gCOD/g of total COD]	0.0001	0.0001
FZbhm - H <sub>2</sub> -utilizing methanogens	[gCOD/g of total COD]	0.0001	0.0001

## Configuration information for all Ideal clarifier units

### Physical data

Element name	Volume [Mil. Gal]	Area [ft <sup>2</sup> ]	Depth [ft]
Final clarifiers	0.7109	8640.0000	11.0

### Operating data Average (flow/time weighted as required)

Element name	Split type	Average Split specification
Final clarifiers	Flowrate [Under]	3596.14

Element name	Average Temperature	Reactive	Percent removal	Blanket fraction
Final clarifiers	Uses global setting	No	98.40	0.05

## Configuration information for all Effluent units

## Configuration information for all Sludge units

### BioWin Album

#### Album page - Influent

BOD Influent			
Parameters	Conc. (mg/L)	Mass rate (lb/d)	Notes
Volatile suspended solids	123.84	6618.09	mmol/L and kmol/d
Total suspended solids	165.15	8825.80	
Particulate COD	198.12	10587.57	
Filtered COD	91.09	4868.11	
Total COD	289.21	15455.68	
Soluble PO4-P	6.85	366.07	
Total P	13.70	732.14	
Filtered TKN	18.65	996.93	
Particulate TKN	3.43	183.04	
Total Kjeldahl Nitrogen	22.08	1179.97	
Filtered Carbonaceous BOD	54.13	2892.62	
Total Carbonaceous BOD	138.98	7427.18	
Total N	22.08	1179.97	
Total inorganic N	16.56	884.98	
Alkalinity	1.32	32.12	
pH	7.60		
Volatile fatty acids	8.68	463.67	
Total precipitated solids	0.00	0.00	
Total inorganic suspended solids	41.31	2207.71	
Ammonia N	16.56	884.98	
Nitrate N	0.00	0.00	
Parameters	Value	Units	
pH	7.60		
Ionized ammonium	16.33	mgN/L	
Unionized ammonia	0.23	mgN/L	
Total dissolved CO2	0.06	mmol/L	
Bicarbonate	1.06	mmol/L	

Carbonate	0.00	mmol/L
Unionized ortho-P	0.00	mgP/L
H <sub>2</sub> PO <sub>4</sub> <sup>-</sup>	1.50	mgP/L
HPO <sub>4</sub> <sup>2-</sup>	5.35	mgP/L
PO <sub>4</sub> <sup>3-</sup>	0.00	mgP/L
Metal phosphate (solid)	0.00	mgTSS/L
Metal hydroxide (solid)	0.00	mgTSS/L
Metal ion	0.00	mgMe/L
MeH <sub>2</sub> PO <sub>4</sub> <sup>++</sup>	0.00	mgMe/L
MeHPO <sub>4</sub> <sup>+</sup>	0.00	mgMe/L
Acetic acid	0.01	mg/L
Acetate	8.67	mg/L
Propionic acid	0.00	mg/L
Propionate	0.00	mg/L
Ionic strength	0.02	
Flow	6.40	mgd

### Album page - Aeration Tanks

Aeration Tanks			
Parameters	Conc. (mg/L)	Mass rate (lb/d)	Notes
Volatile suspended solids	670.66	41689.00	
Total suspended solids	1065.01	66202.71	
Particulate COD	979.79	60905.43	
Filtered COD	17.62	1095.29	
Total COD	997.41	62000.72	
Soluble PO <sub>4</sub> -P	7.80	485.16	
Total P	27.70	1722.01	
Filtered TKN	15.54	965.72	
Particulate TKN	60.51	3761.36	
Total Kjeldahl Nitrogen	76.04	4727.07	
Filtered Carbonaceous BOD	2.14	132.75	
Total Carbonaceous BOD	412.88	25665.22	
Total N	80.31	4992.40	
Total inorganic N	18.15	1128.00	
Alkalinity	1.14	32.21	mmol/L and kmol/d
pH	6.36		
Volatile fatty acids	0.05	2.91	
Total precipitated solids	0.00	0.00	
Total inorganic suspended solids	394.35	24513.71	
Ammonia N	13.88	862.67	
Nitrate N	4.27	265.32	
Parameters	Value	Units	
Hydraulic residence time	3.8	hours	
Flow	7.45	mgd	
MLSS	1065.01	mg/L	
Dissolved oxygen	2.00	mg/L	
Total readily biodegradable COD	2.76	mg/L	
Total oxygen uptake rate	21.18	mgO <sub>2</sub> /L/hr	
Carbonaceous OUR	16.39	mgO <sub>2</sub> /L/hr	
Nitrogenous OUR	4.79	mgO <sub>2</sub> /L/hr	
Nitrate uptake rate	0.12	mgN/L/hr	
Nitrification rate	1.11	mgN/L/hr	
Denitrification rate	0.12	mgN/L/hr	
Spec. denite rate per VSS	0.18	mgN/gVSS/hr	
Spec. denite rate per VASS	0.25	mgN/gVASS/hr	
Net Nitrate production rate	0.99	mgN/L/hr	
OTE	12.67	%	
OTR	213.27	lb/hr	
SOTE	39.29	%	
SOTR	646.26	lb/hr	
Air supply rate	1612.01	ft <sup>3</sup> /min (20C, 1 atm)	
Air flow rate / diffuser	0.71	ft <sup>3</sup> /min (20C, 1 atm)	
# of diffusers	2264.00		
Off gas flow rate (dry)	1596.53	ft <sup>3</sup> /min	
Oxygen content	18.61	%	
Carbon dioxide content	1.74	%	

Ammonia content	0.00	%
Actual DO sat. conc.	8.86	mg/L

### Album page - Effluent

Effluent			
Parameters	Conc. (mg/L)	Mass rate (lb/d)	Notes
Volatile suspended solids	12.30	667.02	
Total suspended solids	19.53	1059.24	
Particulate COD	17.97	974.49	
Filtered COD	17.62	955.60	
Total COD	35.59	1930.08	
Soluble PO4-P	7.80	423.28	
Total P	8.17	443.07	
Filtered TKN	15.54	842.55	
Particulate TKN	1.11	60.18	
Total Kjeldahl Nitrogen	16.65	902.73	
Filtered Carbonaceous BOD	2.14	115.82	
Total Carbonaceous BOD	9.67	524.34	
Total N	20.91	1134.22	
Total inorganic N	18.15	984.13	
Alkalinity	1.14	28.10	mmol/L and kmol/d
pH	6.36		
Volatile fatty acids	0.05	2.54	
Total precipitated solids	0.00	0.00	
Total inorganic suspended solids	7.23	392.22	
Ammonia N	13.88	752.65	
Nitrate N	4.27	231.48	
Parameters	Value	Units	
pH	6.36		
Ionized ammonium	13.87	mgN/L	
Unionized ammonia	0.01	mgN/L	
Total dissolved CO2	1.01	mmol/L	
Bicarbonate	1.10	mmol/L	
Carbonate	0.00	mmol/L	
Unionized ortho-P	0.00	mgP/L	
H2PO4-	6.44	mgP/L	
HPO4--	1.36	mgP/L	
PO4---	0.00	mgP/L	
Metal phosphate (solid)	0.00	mgTSS/L	
Metal hydroxide (solid)	0.00	mgTSS/L	
Metal ion	0.00	mgMe/L	
MeH2PO4++	0.00	mgMe/L	
MeHPO4+	0.00	mgMe/L	
Acetic acid	0.00	mg/L	
Acetate	0.05	mg/L	
Propionic acid	0.00	mg/L	
Propionate	0.00	mg/L	
Ionic strength	0.02		
Flow	6.50	mgd	

### Global Parameters

#### Autotroph

Name	Default	Value	
Max. spec. growth rate [1/d]	0.90000	0.90000	1.0720
Substrate (NH4) half sat. [mgN/L]	0.70000	0.70000	1.0000
Aerobic decay rate [1/d]	0.17000	0.17000	1.0290
Anoxic/anaerobic decay rate [1/d]	0.08000	0.08000	1.0290
CO2 half sat. for autotrophs [mmol/L]	0.01000	0.01000	1.0000

## Heterotroph

Name	Default	Value	
Max. spec. growth rate [1/d]	3.20000	3.20000	1.0290
Substrate half sat. [mgCOD/L]	5.00000	5.00000	1.0000
Anoxic growth factor [-]	0.50000	0.50000	1.0000
Aerobic decay [1/d]	0.62000	0.62000	1.0290
Anoxic/anaerobic decay [1/d]	0.30000	0.30000	1.0290
Hydrolysis rate (AS) [1/d]	2.10000	2.10000	1.0290
Hydrolysis half sat. (AS) [-]	0.06000	0.06000	1.0000
Anoxic hydrolysis factor [-]	0.28000	0.28000	1.0000
Anaerobic hydrolysis factor [-]	0.50000	0.50000	1.0000
Adsorption rate of colloids [L/(mgCOD d)]	0.80000	0.80000	1.0290
Ammonification rate [L/(mgN d)]	0.04000	0.04000	1.0290
Fermentation rate [1/d]	3.20000	3.20000	1.0290
Fermentation half sat. [mgCOD/L]	5.00000	5.00000	1.0000
Anaerobic growth factor (AS) [-]	0.12500	0.12500	1.0000
Hydrolysis rate (AD) [1/d]	0.10000	0.10000	1.0500
Hydrolysis half sat. (AD) [mgCOD/L]	0.15000	0.15000	1.0000

## Methanol utilizers

Name	Default	Value	
Max. spec. growth rate of methanol utilizers [1/d]	6.40000	6.40000	1.0290
Methanol half sat. [mgCOD/L]	0.50000	0.50000	1.0000
Aerobic decay rate of methanol utilizers [1/d]	0.24000	0.24000	1.0290
Anoxic/anaerobic decay rate of methanol utilizers [1/d]	0.12000	0.12000	1.0290

## PolyP

Name	Default	Value	
Max. spec. growth rate [1/d]	0.95000	0.95000	1.0000
Max. spec. growth rate, P-limited [1/d]	0.42000	0.42000	1.0000
Substrate half sat. [mgCOD/L]	0.10000	0.10000	1.0000
Substrate half sat., P-limited [mgCOD/L]	0.05000	0.05000	1.0000
Magnesium half sat. [mgMg/L]	0.10000	0.10000	1.0000
Cation half sat. [mmol/L]	0.10000	0.10000	1.0000
Calcium half sat. [mgCa/L]	0.10000	0.10000	1.0000
Aerobic decay rate [1/d]	0.10000	0.10000	1.0000
Anaerobic decay rate [1/d]	0.04000	0.04000	1.0000
Sequestration rate [1/d]	6.00000	6.00000	1.0000
Anoxic growth factor [-]	0.33000	0.33000	1.0000

## Propionic Acetogen

Name	Default	Value	
Max. spec. growth rate [1/d]	0.25000	0.25000	1.0290
Substrate half sat. [mgCOD/L]	10.00000	10.00000	1.0000
Acetate inhibition [mgCOD/L]	10000.00000	10000.00000	1.0000
Decay rate [1/d]	0.05000	0.05000	1.0290
Aerobic decay rate [1/d]	0.52000	0.52000	1.0290

## Methanogen

Name	Default	Value	
Acetoclastic Mu Max [1/d]	0.30000	0.30000	1.0290
H2-utilizing Mu Max [1/d]	1.40000	1.40000	1.0290
Acetoclastic Ks [mgCOD/L]	100.00000	100.00000	1.0000
H2-utilizing CO2 half sat. [mmol/L]	0.10000	0.10000	1.0000
H2-utilizing Ks [mgCOD/L]	0.10000	0.10000	1.0000
Acetoclastic propionic inhibition [mgCOD/L]	10000.00000	10000.00000	1.0000
Acetoclastic decay rate [1/d]	0.13000	0.13000	1.0290
Acetoclastic aerobic decay rate [1/d]	0.60000	0.60000	1.0290
H2-utilizing decay rate [1/d]	0.13000	0.13000	1.0290
H2-utilizing aerobic decay rate [1/d]	0.60000	0.60000	1.0290

## pH Inhibition

Name	Default	Value
Heterotrophs low pH limit [-]	4.00000	4.00000
Heterotrophs high pH limit [-]	10.00000	10.00000
Methanol utilizers low pH limit [-]	4.00000	4.00000
Methanol utilizers high pH limit [-]	10.00000	10.00000
Autotrophs low pH limit [-]	5.50000	5.50000
Autotrophs high pH limit [-]	9.50000	9.50000
PolyP heterotrophs low pH limit [-]	4.00000	4.00000
Poly P heterotrophs high pH limit [-]	10.00000	10.00000
Heterotrophs low pH limit (anaerobic) [-]	5.50000	5.50000
Heterotrophs high pH limit (anaerobic) [-]	8.50000	8.50000
Propionic acetogens low pH limit [-]	4.00000	4.00000
Propionic acetogens high pH limit [-]	10.00000	10.00000
Acetoclastic methanogens low pH limit [-]	5.50000	5.50000
Acetoclastic methanogens high pH limit [-]	8.50000	8.50000
H <sub>2</sub> -utilizing methanogens low pH limit [-]	5.50000	5.50000
H <sub>2</sub> -utilizing methanogens high pH limit [-]	8.50000	8.50000

## Switching Functions

Name	Default	Value
Heterotrophic DO limit [mgO <sub>2</sub> /L]	0.05000	0.05000
Aerobic denit. DO limit [mgO <sub>2</sub> /L]	0.05000	0.05000
Autotrophic DO limit [mgO <sub>2</sub> /L]	0.25000	0.25000
Anoxic NO <sub>3</sub> limit [mgN/L]	0.10000	0.10000
NH <sub>3</sub> nutrient limit [mgN/L]	0.00500	0.00500
NO <sub>3</sub> nutrient limit [mgN/L]	0.00500	0.00500
PolyP limit [mgP/L]	0.01000	0.01000
VFA sequestration limit [mgCOD/L]	5.00000	5.00000
P uptake limit [mgP/L]	0.15000	0.15000
P nutrient limit [mgP/L]	0.00500	0.00500
Heterotrophic Hydrogen limit [mgCOD/L]	1.00000	1.00000
Propionic acetogens Hydrogen limit [mgCOD/L]	5.00000	5.00000

## Autotroph

Name	Default	Value
Yield [mgCOD/mgN]	0.24000	0.24000
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in inert [mgP/mgCOD]	0.02200	0.02200
Fraction to endogenous residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

## Heterotroph

Name	Default	Value
Yield (aerobic) [-]	0.66600	0.66600
Yield (fermentation, low H <sub>2</sub> ) [-]	0.10000	0.10000
Yield (fermentation, high H <sub>2</sub> ) [-]	0.10000	0.10000
Yield (fermentation of methanol) [-]	0.10000	0.10000
H <sub>2</sub> yield (fermentation low H <sub>2</sub> ) [-]	0.35000	0.35000
H <sub>2</sub> yield (fermentation high H <sub>2</sub> ) [-]	0.0	0.0
H <sub>2</sub> yield (methanol fermentation) [-]	0.35000	0.35000
Propionate yield (fermentation, low H <sub>2</sub> ) [-]	0.0	0.0
Propionate yield (fermentation, high H <sub>2</sub> ) [-]	0.70000	0.70000
CO <sub>2</sub> yield (fermentation, low H <sub>2</sub> ) [-]	0.50000	0.50000
CO <sub>2</sub> yield (fermentation, high H <sub>2</sub> ) [-]	0.0	0.0
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in inert [mgP/mgCOD]	0.02200	0.02200
Endogenous Residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
Yield (anoxic) [-]	0.54000	0.54000
Yield propionic (aerobic) [-]	0.50000	0.50000

Yield propionic (anoxic) [-]	0.41000	0.41000
Yield acetic (aerobic) [-]	0.40000	0.40000
Yield acetic (anoxic) [-]	0.32000	0.32000
Yield methanol (aerobic) [-]	0.50000	0.50000
Adsorp. max. [-]	1.00000	1.00000

### Methanol utilizer

Name	Default	Value
Yield (anoxic) [-]	0.40000	0.40000
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in inert [mgP/mgCOD]	0.02200	0.02200
Endogenous Residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

### PolyP

Name	Default	Value
Yield (aerobic) [-]	0.63900	0.63900
Yield (anoxic) [-]	0.52000	0.52000
Aerobic P/PHA uptake [mgP/mgCOD]	0.95000	0.95000
Anoxic P/PHA uptake [mgP/mgCOD]	0.35000	0.35000
Yield of PHA on sequestration [-]	0.88900	0.88900
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in part. inert [mgN/mgCOD]	0.07000	0.07000
N in sol. inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in part. inert [mgP/mgCOD]	0.02200	0.02200
Fraction to endogenous part. [-]	0.25000	0.25000
Inert fraction of endogenous sol. [-]	0.20000	0.20000
P/Ac release ratio [mgP/mgCOD]	0.49000	0.49000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
Yield of low PP [-]	0.94000	0.94000

### Propionic Acetogen

Name	Default	Value
Yield [-]	0.10000	0.10000
H <sub>2</sub> yield [-]	0.40000	0.40000
CO <sub>2</sub> yield [-]	1.00000	1.00000
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in endogenous residue [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in endogenous residue [mgP/mgCOD]	0.02200	0.02200
Fraction to endogenous residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

### Methanogen

Name	Default	Value
Acetoclastic yield [-]	0.10000	0.10000
H <sub>2</sub> -utilizing yield [-]	0.10000	0.10000
N in acetoclastic biomass [mgN/mgCOD]	0.07000	0.07000
N in H <sub>2</sub> -utilizing biomass [mgN/mgCOD]	0.07000	0.07000
N in acetoclastic endog. residue [mgN/mgCOD]	0.07000	0.07000
N in H <sub>2</sub> -utilizing endog. residue [mgN/mgCOD]	0.07000	0.07000
P in acetoclastic biomass [mgP/mgCOD]	0.02200	0.02200
P in H <sub>2</sub> -utilizing biomass [mgP/mgCOD]	0.02200	0.02200
P in acetoclastic endog. residue [mgP/mgCOD]	0.02200	0.02200
P in H <sub>2</sub> -utilizing endog. residue [mgP/mgCOD]	0.02200	0.02200
Acetoclastic fraction to endog. residue [-]	0.08000	0.08000
H <sub>2</sub> -utilizing fraction to endog. residue [-]	0.08000	0.08000
Acetoclastic COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
H <sub>2</sub> -utilizing COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

## General

Name	Default	Value
Particulate substrate COD:VSS ratio [mgCOD/mgVSS]	1.60000	1.60000
Particulate inert COD:VSS ratio [mgCOD/mgVSS]	1.60000	1.60000
Ash content of biomass (synthesis ISS) [%]	8.00000	8.00000
Molecular weight of other anions [mg/mmol]	35.50000	35.50000
Molecular weight of other cations [mg/mmol]	39.10000	39.10000
Mg to P mole ratio in polyphosphate [mmolMg/mmolP]	0.30000	0.30000
Cation to P mole ratio in polyphosphate [meq/mmolP]	0.30000	0.30000
Ca to P mole ratio in polyphosphate [mmolCa/mmolP]	0.05000	0.05000
Cation to P mole ratio in organic phosphate [meq/mmolP]	0.01000	0.01000
Bubble rise velocity (anaerobic digester) [cm/s]	23.90000	23.90000
Bubble Sauter mean diameter (anaerobic digester) [cm]	0.35000	0.35000

## Mass transfer

Name	Default	Value
Kl for H2 [m/d]	17.00000	17.00000
Kl for CO2 [m/d]	10.00000	10.00000
Kl for NH3 [m/d]	1.00000	1.00000

## Physico-chemical rates

Name	Default	Value
Struvite precipitation rate [1/d]	3.0000E+10	3.0000E+10
Struvite redissolution rate [1/d]	3.0000E+11	3.0000E+11
Struvite half sat. [mgTSS/L]	1.00000	1.00000
HDP precipitation rate [L/(molP d)]	1.0000E+8	1.0000E+8
HDP redissolution rate [L/(mol P d)]	1.0000E+8	1.0000E+8
HAP precipitation rate [molHDP/(L d)]	5.0000E-4	5.0000E-4

## Physico-chemical constants

Name	Default	Value
Struvite solubility constant [mol/L]	6.9180E-14	6.9180E-14
HDP solubility product [mol/L]	2.7500E-22	2.7500E-22
HDP half sat. [mgTSS/L]	1.00000	1.00000
Equilibrium soluble PO4 with Al dosing at pH 7 [mgP/L]	0.01000	0.01000
Al to P ratio [molAl/molP]	0.80000	0.80000
Al(OH)3 solubility product [mol/L]	1.2590E+9	1.2590E+9
AlHPO4+ dissociation constant [mol/L]	7.9430E-13	7.9430E-13
Equilibrium soluble PO4 with Fe dosing at pH 7 [mgP/L]	0.01000	0.01000
Fe to P ratio [molFe/molP]	1.60000	1.60000
Fe(OH)3 solubility product [mol/L]	0.05000	0.05000
FeH2PO4++ dissociation constant [mol/L]	5.0120E-22	5.0120E-22

## Aeration

Name	Default	Value
Alpha (surf) OR Alpha F (diff) [-]	0.50000	0.50000
Beta [-]	0.95000	0.95000
Surface pressure [kPa]	101.32500	101.32500
Fractional effective saturation depth (Fed) [-]	0.32500	0.32500
Supply gas CO2 content [vol. %]	0.03500	0.03500
Supply gas O2 [vol. %]	20.95000	20.95000
Off-gas CO2 [vol. %]	2.00000	2.00000
Off-gas O2 [vol. %]	18.80000	18.80000
Off-gas H2 [vol. %]	0.0	0.0
Off-gas NH3 [vol. %]	0.0	0.0
Surface turbulence factor [-]	0.25000	0.25000
Set point controller gain [-]	1.00000	1.00000

### Modified Vesilind

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [ft/min]	0.3873	0.3873
Vesilind hindered zone settling parameter (K) [L/g]	0.3700	0.3700
Clarification switching function [mg/L]	100.0000	100.0000
Specified TSS conc. for height calc. [mg/L]	2500.0000	2500.0000
Maximum compactability constant [mg/L]	15000.0000	15000.0000

### Double exponential

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [ft/min]	0.9341	0.9341
Maximum (practical) settling velocity (Vo') [ft/min]	0.6152	0.6152
Hindered zone settling parameter (Kh) [L/g]	0.4000	0.4000
Flocculent zone settling parameter (Kf) [L/g]	2.5000	2.5000
Maximum non-settleable TSS [mg/L]	20.0000	20.0000
Non-settleable fraction [-]	0.0010	0.0010
Specified TSS conc. for height calc. [mg/L]	2500.0000	2500.0000

## **APPENDIX D**

**BioWin Model Results for Future Conditions at Increased SRT Operation**

## BioWin user and configuration data

### Project details

Project name: Future Conditions - Plug flow

Plant name: Kingston

Project ref.: 5744001

User name: MARPICATI

Created: 5/23/2006

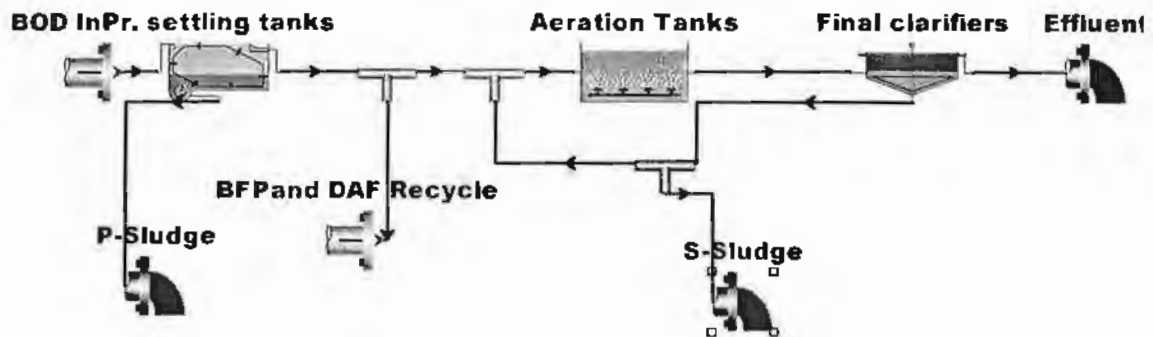
Saved: 8/12/2008

### Steady state solution

SRT: 2.98

Temperature: 20.0

### Flowsheet



## Configuration information for all Ideal primary settling tank units

### Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Pr. settling tanks	0.4625	5472.0000	11.3

### Operating data Average (flow/time weighted as required)

Element name	Split type	Average Split specification
Pr. settling tanks	Flowrate [Under]	0.18

Element name	Percent removal	Blanket fraction
Pr. settling tanks	60.00	0.10

## Configuration information for all Bioreactor units

### Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Aeration Tanks	1.1807	9990.0000	15.8	2264

### Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint
Aeration Tanks	2.0

### Aeration equipment parameters

Element name	$k_1$ in $C = k_1(PC)^{0.25} + k_2$	$k_2$ in $C = k_1(PC)^{0.25} + k_2$	$Y$ in $Kla = C U_{sg} \wedge Y - U_{sg}$ in $[m^3/(m^2 d)]$	Area of one diffuser	% of tank area covered by diffusers [%]
Aeration Tanks	2.5656	0.0432	0.8200	0.0410	10.0000

## Configuration information for all Sidestream Mixer units

### Physical data

Element name	Volume[Mil. Gal]	Area[ft2]	Depth[ft]
Sidestream Mixer7	0	N/A	N/A
Sidestream Mixer10	0	N/A	N/A

## Configuration information for all Splitter units

### Physical data

Element name	Volume[Mil. Gal]	Area[ft2]	Depth[ft]
Splitter4	0	N/A	N/A

### Operating data Average (flow/time weighted as required)

Element name	Split type	Average Split specification
Splitter4	Flowrate [Side]	0.065

## Configuration information for all BOD Influent units

### Operating data Average (flow/time weighted as required)

Element name	BOD Influent	BFPand DAF Recycle
Flow	6.4036	0.343
Total Carbnaceous BOD mg/L	138.98	172.00
Volatile suspended solids mg/L	123.84	119.00
Total suspended solids mgTSS/L	165.13	447.10
Total Kjeldahl Nitrogen mgN/L	22.08	136.00
Total P mgP/L	13.70	10.00
Nitrate N mgN/L	0.00	0.00
pH	7.60	7.30
Alkalinity mmol/L	1.33	12.00
Calcium mg/L	160.00	160.00
Magnesium mg/L	25.00	25.00
Dissolved oxygen mg/L	0.00	0.00

Element name	BOD Influent	BFPand DAF Recycle
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.2000	0.2000
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1500	0.1500
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.8951	0.6884
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0500	0.0500
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300	0.1300
Fna - Ammonia [gNH3-N/gTKN]	0.7500	0.6600
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.5000	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0000	0.0000
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0350	0.0350

Fpo4 - Phosphate [gPO4-P/gTP]	0.5000	0.5000
FupP - P:COD ratio for influent unbiodegradable part. COD [gP/gCOD]	0.0110	0.0110
FZbb - Non-poly-P heterotrophs [gCOD/g of total COD]	0.0001	0.0001
FZbm - Anoxic methanol utilizers [gCOD/g of total COD]	0.0001	0.0001
FZba - Autotrophs [gCOD/g of total COD]	0.0001	0.0001
FZbp - PAOs [gCOD/g of total COD]	0.0001	0.0001
FZbpa - Propionic acetogens [gCOD/g of total COD]	0.0001	0.0001
FZbam - Acetoclastic methanogens [gCOD/g of total COD]	0.0001	0.0001
FZbhm - H2-utilizing methanogens [gCOD/g of total COD]	0.0001	0.0001

## Configuration information for all Ideal clarifier units

### Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Final clarifiers	0.7109	8640.0000	11.0

### Operating data Average (flow/time weighted as required)

Element name	Split type	Average Split specification
Final clarifiers	Flowrate [Under]	4731.77

Element name	Average Temperature	Reactive	Percent removal	Blanket fraction
Final clarifiers	Uses global setting	No	98.40	0.05

## Configuration information for all Effluent units

## Configuration information for all Sludge units

### BioWin Album

#### Album page - Influent

BOD Influent				
Parameters	Conc. (mg/L)	Mass rate (lb/d)	Notes	
Volatile suspended solids	123.84	6618.09		
Total suspended solids	165.15	8825.80		
Particulate COD	198.12	10587.57		
Filtered COD	91.09	4868.11		
Total COD	289.21	15455.68		
Soluble PO4-P	6.85	366.07		
Total P	13.70	732.14		
Filtered TKN	18.65	996.93		
Particulate TKN	3.43	183.04		
Total Kjeldahl Nitrogen	22.08	1179.97		
Filtered Carbonaceous BOD	54.13	2892.62		
Total Carbonaceous BOD	138.98	7427.18		
Total N	22.08	1179.97		
Total inorganic N	16.56	884.98		
Alkalinity	1.32	32.12	mmol/L and kmol/d	
pH	7.60			
Volatile fatty acids	8.68	463.67		
Total precipitated solids	0.00	0.00		
Total inorganic suspended solids	41.31	2207.71		
Ammonia N	16.56	884.98		
Nitrate N	0.00	0.00		
Parameters	Value	Units		
pH	7.60			
Ionized ammonium	16.33	mgN/L		
Unionized ammonia	0.23	mgN/L		

Total dissolved CO <sub>2</sub>	0.06	mmol/L
Bicarbonate	1.06	mmol/L
Carbonate	0.00	mmol/L
Un-ionized ortho-P	0.00	mgP/L
H <sub>2</sub> PO <sub>4</sub> <sup>-</sup>	1.50	mgP/L
HPO <sub>4</sub> <sup>2-</sup>	5.35	mgP/L
PO <sub>4</sub> <sup>3-</sup>	0.00	mgP/L
Metal phosphate (solid)	0.00	mgTSS/L
Metal hydroxide (solid)	0.00	mgTSS/L
Metal ion	0.00	mgMe/L
MeH <sub>2</sub> PO <sub>4</sub> <sup>++</sup>	0.00	mgMe/L
MeHPO <sub>4</sub> <sup>+</sup>	0.00	mgMe/L
Acetic acid	0.01	mg/L
Acetate	8.67	mg/L
Propionic acid	0.00	mg/L
Propionate	0.00	mg/L
Ionic strength	0.02	
Flow	6.40	mgd

### Album page - Aeration Tanks

Aeration Tanks			
Parameters	Conc. (mg/L)	Mass rate (lb/d)	Notes
Volatile suspended solids	779.94	50454.60	
Total suspended solids	1252.02	80993.17	
Particulate COD	1138.73	73664.40	
Filtered COD	17.30	1119.12	
Total COD	1156.02	74783.52	
Soluble PO <sub>4</sub> -P	7.86	508.71	
Total P	30.85	1995.86	
Filtered TKN	11.80	763.13	
Particulate TKN	70.56	4564.68	
Total Kjeldahl Nitrogen	82.36	5327.80	
Filtered Carbonaceous BOD	1.91	123.40	
Total Carbonaceous BOD	469.49	30371.72	
Total N	90.54	5857.24	
Total inorganic N	18.38	1188.98	
Alkalinity	0.60	17.58	mmol/L and kmol/d
pH	6.07		
Volatile fatty acids	0.04	2.66	
Total precipitated solids	0.00	0.00	
Total inorganic suspended solids	472.07	30538.57	
Ammonia N	10.20	659.55	
Nitrate N	8.18	529.43	
Parameters	Value	Units	
Hydraulic residence time	3.7	hours	
Flow	7.75	mgd	
MLSS	1252.02	mg/L	
Dissolved oxygen	2.00	mg/L	
Total readily biodegradable COD	2.48	mg/L	
Total oxygen uptake rate	26.00	mgO <sub>2</sub> /L/hr	
Carbonaceous OUR	17.24	mgO <sub>2</sub> /L/hr	
Nitrogenous OUR	8.76	mgO <sub>2</sub> /L/hr	
Nitrate uptake rate	0.13	mgN/L/hr	
Nitrification rate	2.02	mgN/L/hr	
Denitrification rate	0.13	mgN/L/hr	
Spec. denite rate per VSS	0.16	mgN/gVSS/hr	
Spec. denite rate per VASS	0.23	mgN/gVASS/hr	
Net Nitrate production rate	1.90	mgN/L/hr	
OTE	12.13	%	
OTR	260.78	lb/hr	
SOTE	37.59	%	
SOTR	790.26	lb/hr	
Air supply rate	2060.19	ft <sup>3</sup> /min (20C, 1 atm)	
Air flow rate / diffuser	0.91	ft <sup>3</sup> /min (20C, 1 atm)	
# of diffusers	2264.00		
Off gas flow rate (dry)	2044.00	ft <sup>3</sup> /min	

Oxygen content	18.66	%
Carbon dioxide content	1.80	%
Ammonia content	0.00	%
Actual DO sat. conc.	8.86	mg/L

## Album page - Effluent

Effluent			
Parameters	Conc. (mg/L)	Mass rate (lb/d)	Notes
Volatile suspended solids	14.88	807.27	
Total suspended solids	23.88	1295.89	
Particulate COD	21.72	1178.63	
Filtered COD	17.30	938.65	
Total COD	39.02	2117.28	
Soluble PO4-P	7.86	426.68	
Total P	8.30	450.47	
Filtered TKN	11.80	640.07	
Particulate TKN	1.35	73.03	
Total Kjeldahl Nitrogen	13.14	713.10	
Filtered Carbonaceous BOD	1.91	103.50	
Total Carbonaceous BOD	10.83	587.48	
Total N	21.33	1157.16	
Total inorganic N	18.38	997.25	
Alkalinity	0.60	14.74	mmol/L and kmol/d
pH	6.07		
Volatile fatty acids	0.04	2.23	
Total precipitated solids	0.00	0.00	
Total inorganic suspended solids	9.01	488.62	
Ammonia N	10.20	553.19	
Nitrate N	8.18	444.06	
Parameters	Value	Units	
pH	6.07		
Ionized ammonium	10.19	mgN/L	
Unionized ammonia	0.00	mgN/L	
Total dissolved CO2	1.03	mmol/L	
Bicarbonate	0.57	mmol/L	
Carbonate	0.00	mmol/L	
Unionized ortho-P	0.00	mgP/L	
H2PO4-	7.09	mgP/L	
HPO4--	0.77	mgP/L	
PO4---	0.00	mgP/L	
Metal phosphate (solid)	0.00	mgTSS/L	
Metal hydroxide (solid)	0.00	mgTSS/L	
Metal ion	0.00	mgMe/L	
MeH2PO4++	0.00	mgMe/L	
MeHPO4+	0.00	mgMe/L	
Acetic acid	0.00	mg/L	
Acetate	0.04	mg/L	
Propionic acid	0.00	mg/L	
Propionate	0.00	mg/L	
Ionic strength	0.02		
Flow	6.50	mgd	

## Global Parameters

### Autotroph

Name	Default	Value	
Max. spec. growth rate [1/d]	0.90000	0.90000	1.0720
Substrate (NH4) half sat. [mgN/L]	0.70000	0.70000	1.0000
Aerobic decay rate [1/d]	0.17000	0.17000	1.0290
Anoxic/anaerobic decay rate [1/d]	0.08000	0.08000	1.0290
CO2 half sat. for autotrophs [mmol/L]	0.01000	0.01000	1.0000

## Heterotroph

Name	Default	Value	
Max. spec. growth rate [1/d]	3.20000	3.20000	1.0290
Substrate half sat. [mgCOD/L]	5.00000	5.00000	1.0000
Anoxic growth factor [-]	0.50000	0.50000	1.0000
Aerobic decay [1/d]	0.62000	0.62000	1.0290
Anoxic/anaerobic decay [1/d]	0.30000	0.30000	1.0290
Hydrolysis rate (AS) [1/d]	2.10000	2.10000	1.0290
Hydrolysis half sat. (AS) [-]	0.06000	0.06000	1.0000
Anoxic hydrolysis factor [-]	0.28000	0.28000	1.0000
Anaerobic hydrolysis factor [-]	0.50000	0.50000	1.0000
Adsorption rate of colloids [L/(mgCOD d)]	0.80000	0.80000	1.0290
Ammonification rate [L/(mgN d)]	0.04000	0.04000	1.0290
Fermentation rate [1/d]	3.20000	3.20000	1.0290
Fermentation half sat. [mgCOD/L]	5.00000	5.00000	1.0000
Anaerobic growth factor (AS) [-]	0.12500	0.12500	1.0000
Hydrolysis rate (AD) [1/d]	0.10000	0.10000	1.0500
Hydrolysis half sat. (AD) [mgCOD/L]	0.15000	0.15000	1.0000

## Methanol utilizers

Name	Default	Value	
Max. spec. growth rate of methanol utilizers [1/d]	6.40000	6.40000	1.0290
Methanol half sat. [mgCOD/L]	0.50000	0.50000	1.0000
Aerobic decay rate of methanol utilizers [1/d]	0.24000	0.24000	1.0290
Anoxic/anaerobic decay rate of methanol utilizers [1/d]	0.12000	0.12000	1.0290

## PolyP

Name	Default	Value	
Max. spec. growth rate [1/d]	0.95000	0.95000	1.0000
Max. spec. growth rate, P-limited [1/d]	0.42000	0.42000	1.0000
Substrate half sat. [mgCOD/L]	0.10000	0.10000	1.0000
Substrate half sat., P-limited [mgCOD/L]	0.05000	0.05000	1.0000
Magnesium half sat. [mgMg/L]	0.10000	0.10000	1.0000
Cation half sat. [mmol/L]	0.10000	0.10000	1.0000
Calcium half sat. [mgCa/L]	0.10000	0.10000	1.0000
Aerobic decay rate [1/d]	0.10000	0.10000	1.0000
Anaerobic decay rate [1/d]	0.04000	0.04000	1.0000
Sequestration rate [1/d]	6.00000	6.00000	1.0000
Anoxic growth factor [-]	0.33000	0.33000	1.0000

## Propionic Acetogen

Name	Default	Value	
Max. spec. growth rate [1/d]	0.25000	0.25000	1.0290
Substrate half sat. [mgCOD/L]	10.00000	10.00000	1.0000
Acetate inhibition [mgCOD/L]	10000.00000	10000.00000	1.0000
Decay rate [1/d]	0.05000	0.05000	1.0290
Aerobic decay rate [1/d]	0.52000	0.52000	1.0290

## Methanogen

Name	Default	Value	
Acetoclastic Mu Max [1/d]	0.30000	0.30000	1.0290
H2-utilizing Mu Max [1/d]	1.40000	1.40000	1.0290
Acetoclastic Ks [mgCOD/L]	100.00000	100.00000	1.0000
H2-utilizing CO2 half sat. [mmol/L]	0.10000	0.10000	1.0000
H2-utilizing Ks [mgCOD/L]	0.10000	0.10000	1.0000
Acetoclastic propionic inhibition [mgCOD/L]	10000.00000	10000.00000	1.0000
Acetoclastic decay rate [1/d]	0.13000	0.13000	1.0290
Acetoclastic aerobic decay rate [1/d]	0.60000	0.60000	1.0290
H2-utilizing decay rate [1/d]	0.13000	0.13000	1.0290
H2-utilizing aerobic decay rate [1/d]	0.60000	0.60000	1.0290

## pH Inhibition

Name	Default	Value
Heterotrophs low pH limit [-]	4.00000	4.00000
Heterotrophs high pH limit [-]	10.00000	10.00000
Methanol utilizers low pH limit [-]	4.00000	4.00000
Methanol utilizers high pH limit [-]	10.00000	10.00000
Autotrophs low pH limit [-]	5.50000	5.50000
Autotrophs high pH limit [-]	9.50000	9.50000
PolyP heterotrophs low pH limit [-]	4.00000	4.00000
Poly P heterotrophs high pH limit [-]	10.00000	10.00000
Heterotrophs low pH limit (anaerobic) [-]	5.50000	5.50000
Heterotrophs high pH limit (anaerobic) [-]	8.50000	8.50000
Propionic acetogens low pH limit [-]	4.00000	4.00000
Propionic acetogens high pH limit [-]	10.00000	10.00000
Acetoclastic methanogens low pH limit [-]	5.50000	5.50000
Acetoclastic methanogens high pH limit [-]	8.50000	8.50000
H <sub>2</sub> -utilizing methanogens low pH limit [-]	5.50000	5.50000
H <sub>2</sub> -utilizing methanogens high pH limit [-]	8.50000	8.50000

## Switching Functions

Name	Default	Value
Heterotrophic DO limit [mgO <sub>2</sub> /L]	0.05000	0.05000
Aerobic denit. DO limit [mgO <sub>2</sub> /L]	0.05000	0.05000
Autotrophic DO limit [mgO <sub>2</sub> /L]	0.25000	0.25000
Anoxic NO <sub>3</sub> limit [mgN/L]	0.10000	0.10000
NH <sub>3</sub> nutrient limit [mgN/L]	0.00500	0.00500
NO <sub>3</sub> nutrient limit [mgN/L]	0.00500	0.00500
PolyP limit [mgP/L]	0.01000	0.01000
VFA sequestration limit [mgCOD/L]	5.00000	5.00000
P uptake limit [mgP/L]	0.15000	0.15000
P nutrient limit [mgP/L]	0.00500	0.00500
Heterotrophic Hydrogen limit [mgCOD/L]	1.00000	1.00000
Propionic acetogens Hydrogen limit [mgCOD/L]	5.00000	5.00000

## Autotroph

Name	Default	Value
Yield [mgCOD/mgN]	0.24000	0.24000
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in inert [mgP/mgCOD]	0.02200	0.02200
Fraction to endogenous residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

## Heterotroph

Name	Default	Value
Yield (aerobic) [-]	0.66600	0.66600
Yield (fermentation, low H <sub>2</sub> ) [-]	0.10000	0.10000
Yield (fermentation, high H <sub>2</sub> ) [-]	0.10000	0.10000
Yield (fermentation of methanol) [-]	0.10000	0.10000
H <sub>2</sub> yield (fermentation low H <sub>2</sub> ) [-]	0.35000	0.35000
H <sub>2</sub> yield (fermentation high H <sub>2</sub> ) [-]	0.0	0.0
H <sub>2</sub> yield (methanol fermentation) [-]	0.35000	0.35000
Propionate yield (fermentation, low H <sub>2</sub> ) [-]	0.0	0.0
Propionate yield (fermentation, high H <sub>2</sub> ) [-]	0.70000	0.70000
CO <sub>2</sub> yield (fermentation, low H <sub>2</sub> ) [-]	0.50000	0.50000
CO <sub>2</sub> yield (fermentation, high H <sub>2</sub> ) [-]	0.0	0.0
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in inert [mgP/mgCOD]	0.02200	0.02200
Endogenous Residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
Yield (anoxic) [-]	0.54000	0.54000
Yield propionic (aerobic) [-]	0.50000	0.50000

Yield propionic (anoxic) [-]	0.41000	0.41000
Yield acetic (aerobic) [-]	0.40000	0.40000
Yield acetic (anoxic) [-]	0.32000	0.32000
Yield methanol (aerobic) [-]	0.50000	0.50000
Adsorp. max. [-]	1.00000	1.00000

### Methanol utilizer

Name	Default	Value
Yield (anoxic) [-]	0.40000	0.40000
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in inert [mgP/mgCOD]	0.02200	0.02200
Endogenous Residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

### PolyP

Name	Default	Value
Yield (aerobic) [-]	0.63900	0.63900
Yield (anoxic) [-]	0.52000	0.52000
Aerobic P/PHA uptake [mgP/mgCOD]	0.95000	0.95000
Anoxic P/PHA uptake [mgP/mgCOD]	0.35000	0.35000
Yield of PHA on sequestration [-]	0.88900	0.88900
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in part. inert [mgN/mgCOD]	0.07000	0.07000
N in sol. inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in part. inert [mgP/mgCOD]	0.02200	0.02200
Fraction to endogenous part. [-]	0.25000	0.25000
Inert fraction of endogenous sol. [-]	0.20000	0.20000
P/Ac release ratio [mgP/mgCOD]	0.49000	0.49000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
Yield of low PP [-]	0.94000	0.94000

### Propionic Acetogen

Name	Default	Value
Yield [-]	0.10000	0.10000
H <sub>2</sub> yield [-]	0.40000	0.40000
CO <sub>2</sub> yield [-]	1.00000	1.00000
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in endogenous residue [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in endogenous residue [mgP/mgCOD]	0.02200	0.02200
Fraction to endogenous residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

### Methanogen

Name	Default	Value
Acetoclastic yield [-]	0.10000	0.10000
H <sub>2</sub> -utilizing yield [-]	0.10000	0.10000
N in acetoclastic biomass [mgN/mgCOD]	0.07000	0.07000
N in H <sub>2</sub> -utilizing biomass [mgN/mgCOD]	0.07000	0.07000
N in acetoclastic endog. residue [mgN/mgCOD]	0.07000	0.07000
N in H <sub>2</sub> -utilizing endog. residue [mgN/mgCOD]	0.07000	0.07000
P in acetoclastic biomass [mgP/mgCOD]	0.02200	0.02200
P in H <sub>2</sub> -utilizing biomass [mgP/mgCOD]	0.02200	0.02200
P in acetoclastic endog. residue [mgP/mgCOD]	0.02200	0.02200
P in H <sub>2</sub> -utilizing endog. residue [mgP/mgCOD]	0.02200	0.02200
Acetoclastic fraction to endog. residue [-]	0.08000	0.08000
H <sub>2</sub> -utilizing fraction to endog. residue [-]	0.08000	0.08000
Acetoclastic COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
H <sub>2</sub> -utilizing COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

## General

Name	Default	Value
Particulate substrate COD:VSS ratio [mgCOD/mgVSS]	1.60000	1.60000
Particulate inert COD:VSS ratio [mgCOD/mgVSS]	1.60000	1.60000
Ash content of biomass (synthesis ISS) [%]	8.00000	8.00000
Molecular weight of other anions [mg/mmol]	35.50000	35.50000
Molecular weight of other cations [mg/mmol]	39.10000	39.10000
Mg to P mole ratio in polyphosphate [mmolMg/mmolP]	0.30000	0.30000
Cation to P mole ratio in polyphosphate [meq/mmolP]	0.30000	0.30000
Ca to P mole ratio in polyphosphate [mmolCa/mmolP]	0.05000	0.05000
Cation to P mole ratio in organic phosphate [meq/mmolP]	0.01000	0.01000
Bubble rise velocity (anaerobic digester) [cm/s]	23.90000	23.90000
Bubble Sauter mean diameter (anaerobic digester) [cm]	0.35000	0.35000

## Mass transfer

Name	Default	Value
Kl for H2 [m/d]	17.00000	17.00000
Kl for CO2 [m/d]	10.00000	10.00000
Kl for NH3 [m/d]	1.00000	1.00000

## Physico-chemical rates

Name	Default	Value
Struvite precipitation rate [1/d]	3.0000E+10	3.0000E+10
Struvite redissolution rate [1/d]	3.0000E+11	3.0000E+11
Struvite half sat. [mgTSS/L]	1.00000	1.00000
HDP precipitation rate [L/(molP d)]	1.0000E+8	1.0000E+8
HDP redissolution rate [L/(mol P d)]	1.0000E+8	1.0000E+8
HAP precipitation rate [molHDP/(L d)]	5.0000E-4	5.0000E-4

## Physico-chemical constants

Name	Default	Value
Struvite solubility constant [mol/L]	6.9180E-14	6.9180E-14
HDP solubility product [mol/L]	2.7500E-22	2.7500E-22
HDP half sat. [mgTSS/L]	1.00000	1.00000
Equilibrium soluble PO4 with Al dosing at pH 7 [mgP/L]	0.01000	0.01000
Al to P ratio [molAl/molP]	0.80000	0.80000
Al(OH)3 solubility product [mol/L]	1.2590E+9	1.2590E+9
AlHPO4+ dissociation constant [mol/L]	7.9430E-13	7.9430E-13
Equilibrium soluble PO4 with Fe dosing at pH 7 [mgP/L]	0.01000	0.01000
Fe to P ratio [molFe/molP]	1.60000	1.60000
Fe(OH)3 solubility product [mol/L]	0.05000	0.05000
FeH2PO4++ dissociation constant [mol/L]	5.0120E-22	5.0120E-22

## Aeration

Name	Default	Value
Alpha (surf) OR Alpha F (diff) [-]	0.50000	0.50000
Beta [-]	0.95000	0.95000
Surface pressure [kPa]	101.32500	101.32500
Fractional effective saturation depth (Fed) [-]	0.32500	0.32500
Supply gas CO2 content [vol. %]	0.03500	0.03500
Supply gas O2 [vol. %]	20.95000	20.95000
Off-gas CO2 [vol. %]	2.00000	2.00000
Off-gas O2 [vol. %]	18.80000	18.80000
Off-gas H2 [vol. %]	0.0	0.0
Off-gas NH3 [vol. %]	0.0	0.0
Surface turbulence factor [-]	0.25000	0.25000
Set point controller gain [-]	1.00000	1.00000

### Modified Vesilind

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [ft/min]	0.3873	0.3873
Vesilind hindered zone settling parameter (K) [L/g]	0.3700	0.3700
Clarification switching function [mg/L]	100.0000	100.0000
Specified TSS conc. for height calc. [mg/L]	2500.0000	2500.0000
Maximum compactability constant [mg/L]	15000.0000	15000.0000

### Double exponential

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [ft/min]	0.9341	0.9341
Maximum (practical) settling velocity (Vo') [ft/min]	0.6152	0.6152
Hindered zone settling parameter (Kh) [L/g]	0.4000	0.4000
Flocculent zone settling parameter (Kf) [L/g]	2.5000	2.5000
Maximum non-settleable TSS [mg/L]	20.0000	20.0000
Non-settleable fraction [-]	0.0010	0.0010
Specified TSS conc. for height calc. [mg/L]	2500.0000	2500.0000

## **APPENDIX E**

**BioWin Model Results for Future Conditions at Contact Stabilization Operation**

## BioWin user and configuration data

### Project details

Project name: Future Conditions - Contact Stabilization  
Plant name: Kingston

Project ref.: 5744001  
User name: MARPICATI

Created: 5/23/2006

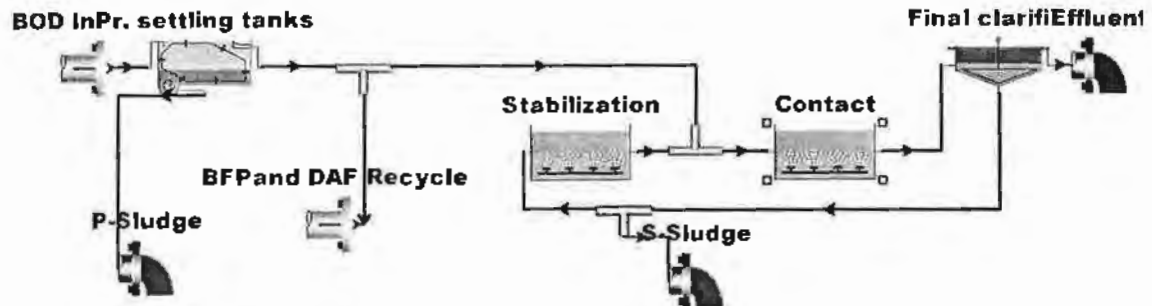
Saved: 8/12/2008

### Steady state solution

SRT #0: 12.34

Temperature: 20.0

### Flowsheet



## Configuration information for all Ideal primary settling tank units

### Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Pr. settling tanks	0.4625	5472.0000	11.3

### Operating data Average (flow/time weighted as required)

Element name	Split type	Average Split specification
Pr. settling tanks	Flowrate [Under]	0.18

Element name	Percent removal	Blanket fraction
Pr. settling tanks	60.00	0.10

## Configuration information for all Bioreactor units

### Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Contact	0.3936	3330.0000	15.8	755
Stabilization	0.7872	6660.0000	15.8	1509

### Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint
Contact	2.0
Stabilization	2.0

### Aeration equipment parameters

Element name	$k_1$ in $C = k_1(PC)^{0.25} + k_2$	$k_2$ in $C = k_1(PC)^{0.25} + k_2$	$Y$ in $Kla = C Usg \wedge Y - Usg$ in $[m^3/(m^2 d)]$	Area of one diffuser	% of tank area covered by diffusers [%]
Contact	2.5656	0.0432	0.8200	0.0410	10.0000
Stabilization	2.5656	0.0432	0.8200	0.0410	10.0000

### Configuration information for all Sidestream Mixer units

#### Physical data

Element name	Volume[Mil. Gal]	Area[ft <sup>2</sup> ]	Depth[ft]
Sidestream Mixer10	0	N/A	N/A
Sidestream Mixer11	0	N/A	N/A

### Configuration information for all Splitter units

#### Physical data

Element name	Volume[Mil. Gal]	Area[ft <sup>2</sup> ]	Depth[ft]
Splitter4	0	N/A	N/A

### Operating data Average (flow/time weighted as required)

Element name	Split type	Average Split specification
Splitter4	Flowrate [Side]	0.065

### Configuration information for all BOD Influent units

#### Operating data Average (flow/time weighted as required)

Element name	BOD Influent	BFPand DAF Recycle
Flow	6.4036	0.343
Total Carbonaceous BOD mg/L	138.98	172.00
Volatile suspended solids mg/L	123.84	119.50
Total suspended solids mgTSS/L	165.13	447.10
Total Kjeldahl Nitrogen mgN/L	22.08	136.00
Total P mgP/L	13.70	10.00
Nitrate N mgN/L	0.00	0.00
pH	7.60	7.30
Alkalinity mmol/L	1.33	12.00
Calcium mg/L	160.00	160.00
Magnesium mg/L	25.00	25.00
Dissolved oxygen mg/L	0.00	0.00

Element name	BOD Influent	BFPand DAF Recycle
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.2000	0.2000
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1500	0.1500
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.8951	0.6916
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0500	0.0500
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300	0.1300
Fna - Ammonia [gNH3-N/gTKN]	0.7500	0.6600
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.5000	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0000	0.0000
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0350	0.0350

Fpo4 - Phosphate [gPO4-P/gTP]	0.5000	0.5000
FupP - P:COD ratio for influent unbiodegradable part. COD [gP/gCOD]	0.0110	0.0110
FZbh - Non-poly-P heterotrophs [gCOD/g of total COD]	0.0001	0.0001
FZbm - Anoxic methanol utilizers [gCOD/g of total COD]	0.0001	0.0001
FZba - Autotrophs [gCOD/g of total COD]	0.0001	0.0001
FZbp - PAOs [gCOD/g of total COD]	0.0001	0.0001
FZbpa - Propionic acetogens [gCOD/g of total COD]	0.0001	0.0001
FZbam - Acetoclastic methanogens [gCOD/g of total COD]	0.0001	0.0001
FZbhm - H2-utilizing methanogens [gCOD/g of total COD]	0.0001	0.0001

## Configuration information for all Ideal clarifier units

### Physical data

Element name	Volume [Mil. Gal]	Area [ft <sup>2</sup> ]	Depth [ft]
Final clarifiers	0.7109	8640.0000	11.0

### Operating data Average (flow/time weighted as required)

Element name	Split type	Average Split specification
Final clarifiers	Flowrate [Under]	3596.14

Element name	Average Temperature	Reactive	Percent removal	Blanket fraction
Final clarifiers	Uses global setting	No	98.40	0.05

## Configuration information for all Effluent units

## Configuration information for all Sludge units

### BioWin Album

#### Album page - Influent

BOD Influent			
Parameters	Conc. (mg/L)	Mass rate (lb/d)	Notes
Volatile suspended solids	123.84	6618.09	
Total suspended solids	165.15	8825.80	
Particulate COD	198.12	10587.57	
Filtered COD	91.09	4868.11	
Total COD	289.21	15455.68	
Soluble PO4-P	6.85	366.07	
Total P	13.70	732.14	
Filtered TKN	18.65	996.93	
Particulate TKN	3.43	183.04	
Total Kjeldahl Nitrogen	22.08	1179.97	
Filtered Carbonaceous BOD	54.13	2892.62	
Total Carbonaceous BOD	138.98	7427.18	
Total N	22.08	1179.97	
Total inorganic N	16.56	884.98	
Alkalinity	1.32	32.12	mmol/L and kmol/d
pH	7.60		
Volatile fatty acids	8.68	463.67	
Total precipitated solids	0.00	0.00	
Total inorganic suspended solids	41.31	2207.71	
Ammonia N	16.56	884.98	
Nitrate N	0.00	0.00	
Parameters	Value	Units	
pH	7.60		
Ionized ammonium	16.33	mgN/L	
Unionized ammonia	0.23	mgN/L	

Total dissolved CO2	0.06	mmol/L
Bicarbonate	1.06	mmol/L
Carbonate	0.00	mmol/L
Unionized ortho-P	0.00	mgP/L
H2PO4-	1.50	mgP/L
HPO4--	5.35	mgP/L
PO4---	0.00	mgP/L
Metal phosphate (solid)	0.00	mgTSS/L
Metal hydroxide (solid)	0.00	mgTSS/L
Metal ion	0.00	mgMe/L
MeH2PO4++	0.00	mgMe/L
MeHPO4+	0.00	mgMe/L
Acetic acid	0.01	mg/L
Acetate	8.67	mg/L
Propionic acid	0.00	mg/L
Propionate	0.00	mg/L
Ionic strength	0.02	
Flow	6.40	mgd

### Album page - Stabilization

Stabilization			
Parameters	Conc. (mg/L)	Mass rate (lb/d)	Notes
Volatile suspended solids	2943.69	21741.13	
Total suspended solids	5831.69	43071.00	
Particulate COD	4344.91	32090.12	
Filtered COD	15.84	116.98	
Total COD	4360.75	32207.10	
Soluble PO4-P	22.61	166.97	
Total P	103.24	762.48	
Filtered TKN	15.68	115.82	
Particulate TKN	254.39	1878.84	
Total Kjeldahl Nitrogen	270.07	1994.66	
Filtered Carbonaceous BOD	0.87	6.43	
Total Carbonaceous BOD	1080.76	7982.16	
Total N	283.45	2093.47	
Total inorganic N	27.87	205.83	
Alkalinity	0.06	0.21	mmol/L and kmol/d
pH	5.09		
Volatile fatty acids	0.00	0.00	
Total precipitated solids	0.00	0.00	
Total inorganic suspended solids	2888.00	21329.87	
Ammonia N	14.49	107.02	
Nitrate N	13.38	98.81	
Parameters	Value	Units	
Hydraulic residence time	21.3	hours	
Flow	0.88	mgd	
MLSS	5831.69	mg/L	
Dissolved oxygen	2.00	mg/L	
Total readily biodegradable COD	1.23	mg/L	
Total oxygen uptake rate	24.99	mgO/L/hr	
Carbonaceous OUR	21.94	mgO/L/hr	
Nitrogenous OUR	3.05	mgO/L/hr	
Nitrate uptake rate	0.16	mgN/L/hr	
Nitrification rate	0.70	mgN/L/hr	
Denitrification rate	0.16	mgN/L/hr	
Spec. denite rate per VSS	0.05	mgN/gVSS/hr	
Spec. denite rate per VASS	0.12	mgN/gVASS/hr	
Net Nitrate production rate	0.54	mgN/L/hr	
OTE	12.28	%	
OTR	164.18	lb/hr	
SOTE	38.07	%	
SOTR	497.51	lb/hr	
Air supply rate	1280.80	ft3/min (20C, 1 atm)	
Air flow rate / diffuser	0.85	ft3/min (20C, 1 atm)	
# of diffusers	1509.00		
Off gas flow rate (dry)	1279.73	ft3/min	

Oxygen content	18.40	%
Carbon dioxide content	2.51	%
Ammonia content	0.00	%
Actual DO sat. conc.	8.86	mg/L

### Album page - Contact

Contact			
Parameters	Conc. (mg/L)	Mass rate (lb/d)	Notes
Volatile suspended solids	417.98	25992.60	
Total suspended solids	791.95	49248.65	
Particulate COD	621.90	38673.81	
Filtered COD	35.44	2203.62	
Total COD	657.33	40877.43	
Soluble PO4-P	8.53	530.22	
Total P	20.80	1293.31	
Filtered TKN	20.43	1270.66	
Particulate TKN	34.29	2132.32	
Total Kjeldahl Nitrogen	54.72	3402.98	
Filtered Carbonaceous BOD	14.71	915.06	
Total Carbonaceous BOD	191.51	11909.10	
Total N	56.54	3515.98	
Total inorganic N	19.90	1237.47	
Alkalinity	1.59	44.95	mmol/L and kmol/d
pH	6.58		
Volatile fatty acids	0.39	24.07	
Total precipitated solids	0.00	0.00	
Total inorganic suspended solids	373.97	23256.05	
Ammonia N	18.08	1124.47	
Nitrate N	1.82	113.00	

Parameters	Value	Units
Hydraulic residence time	1.3	hours
Flow	7.45	mgd
MLSS	791.95	mg/L
Dissolved oxygen	2.00	mg/L
Total readily biodegradable COD	18.34	mg/L
Total oxygen uptake rate	17.17	mgO/L/hr
Carbonaceous OUR	15.92	mgO/L/hr
Nitrogenous OUR	1.25	mgO/L/hr
Nitrate uptake rate	0.11	mgN/L/hr
Nitrification rate	0.29	mgN/L/hr
Denitrification rate	0.11	mgN/L/hr
Spec. denite rate per VSS	0.26	mgN/gVSS/hr
Spec. denite rate per VASS	0.62	mgN/gVASS/hr
Net Nitrate production rate	0.18	mgN/L/hr
OTE	13.11	%
OTR	60.97	lb/hr
SOTE	40.64	%
SOTR	184.75	lb/hr
Air supply rate	445.56	ft <sup>3</sup> /min (20C, 1 atm)
Air flow rate / diffuser	0.59	ft <sup>3</sup> /min (20C, 1 atm)
# of diffusers	755.00	
Off gas flow rate (dry)	432.93	ft <sup>3</sup> /min
Oxygen content	19.16	%
Carbon dioxide content	0.00	%
Ammonia content	0.00	%
Actual DO sat. conc.	8.86	mg/L

### Album page - Effluent

Effluent			
Parameters	Conc. (mg/L)	Mass rate (lb/d)	Notes
Volatile suspended solids	7.66	415.88	
Total suspended solids	14.52	787.98	
Particulate COD	11.40	618.78	
Filtered COD	35.44	1922.68	

Fermentation rate [1/d]	3.20000	3.20000	1.0290
Fermentation half sat. [mgCOD/L]	5.00000	5.00000	1.0000
Anaerobic growth factor (AS) [-]	0.12500	0.12500	1.0000
Hydrolysis rate (AD) [1/d]	0.10000	0.10000	1.0500
Hydrolysis half sat. (AD) [mgCOD/L]	0.15000	0.15000	1.0000

### Methanol utilizers

Name	Default	Value	
Max. spec. growth rate of methanol utilizers [1/d]	6.40000	6.40000	1.0290
Methanol half sat. [mgCOD/L]	0.50000	0.50000	1.0000
Aerobic decay rate of methanol utilizers [1/d]	0.24000	0.24000	1.0290
Anoxic/anaerobic decay rate of methanol utilizers [1/d]	0.12000	0.12000	1.0290

### PolyP

Name	Default	Value	
Max. spec. growth rate [1/d]	0.95000	0.95000	1.0000
Max. spec. growth rate, P-limited [1/d]	0.42000	0.42000	1.0000
Substrate half sat. [mgCOD/L]	0.10000	0.10000	1.0000
Substrate half sat., P-limited [mgCOD/L]	0.05000	0.05000	1.0000
Magnesium half sat. [mgMg/L]	0.10000	0.10000	1.0000
Cation half sat. [mmol/L]	0.10000	0.10000	1.0000
Calcium half sat. [mgCa/L]	0.10000	0.10000	1.0000
Aerobic decay rate [1/d]	0.10000	0.10000	1.0000
Anaerobic decay rate [1/d]	0.04000	0.04000	1.0000
Sequestration rate [1/d]	6.00000	6.00000	1.0000
Anoxic growth factor [-]	0.33000	0.33000	1.0000

### Propionic Acetogen

Name	Default	Value	
Max. spec. growth rate [1/d]	0.25000	0.25000	1.0290
Substrate half sat. [mgCOD/L]	10.00000	10.00000	1.0000
Acetate inhibition [mgCOD/L]	10000.00000	10000.00000	1.0000
Decay rate [1/d]	0.05000	0.05000	1.0290
Aerobic decay rate [1/d]	0.52000	0.52000	1.0290

### Methanogen

Name	Default	Value	
Acetoclastic Mu Max [1/d]	0.30000	0.30000	1.0290
H2-utilizing Mu Max [1/d]	1.40000	1.40000	1.0290
Acetoclastic Ks [mgCOD/L]	100.00000	100.00000	1.0000
H2-utilizing CO2 half sat. [mmol/L]	0.10000	0.10000	1.0000
H2-utilizing Ks [mgCOD/L]	0.10000	0.10000	1.0000
Acetoclastic propionic inhibition [mgCOD/L]	10000.00000	10000.00000	1.0000
Acetoclastic decay rate [1/d]	0.13000	0.13000	1.0290
Acetoclastic aerobic decay rate [1/d]	0.60000	0.60000	1.0290
H2-utilizing decay rate [1/d]	0.13000	0.13000	1.0290
H2-utilizing aerobic decay rate [1/d]	0.60000	0.60000	1.0290

### pH Inhibition

Name	Default	Value	
Heterotrophs low pH limit [-]	4.00000	4.00000	
Heterotrophs high pH limit [-]	10.00000	10.00000	
Methanol utilizers low pH limit [-]	4.00000	4.00000	
Methanol utilizers high pH limit [-]	10.00000	10.00000	
Autotrophs low pH limit [-]	5.50000	5.50000	
Autotrophs high pH limit [-]	9.50000	9.50000	
PolyP heterotrophs low pH limit [-]	4.00000	4.00000	
Poly P heterotrophs high pH limit [-]	10.00000	10.00000	
Heterotrophs low pH limit (anaerobic) [-]	5.50000	5.50000	
Heterotrophs high pH limit (anaerobic) [-]	8.50000	8.50000	
Propionic acetogens low pH limit [-]	4.00000	4.00000	
Propionic acetogens high pH limit [-]	10.00000	10.00000	
Acetoclastic methanogens low pH limit [-]	5.50000	5.50000	

Acetoclastic methanogens high pH limit [-]	8.50000	8.50000
H2-utilizing methanogens low pH limit [-]	5.50000	5.50000
H2-utilizing methanogens high pH limit [-]	8.50000	8.50000

### Switching Functions

Name	Default	Value
Heterotrophic DO limit [mgO2/L]	0.05000	0.05000
Aerobic denit. DO limit [mgO2/L]	0.05000	0.05000
Autotrophic DO limit [mgO2/L]	0.25000	0.25000
Anoxic NO3 limit [mgN/L]	0.10000	0.10000
NH3 nutrient limit [mgN/L]	0.00500	0.00500
NO3 nutrient limit [mgN/L]	0.00500	0.00500
PolyP limit [mgP/L]	0.01000	0.01000
VFA sequestration limit [mgCOD/L]	5.00000	5.00000
P uptake limit [mgP/L]	0.15000	0.15000
P nutrient limit [mgP/L]	0.00500	0.00500
Heterotrophic Hydrogen limit [mgCOD/L]	1.00000	1.00000
Propionic acetogens Hydrogen limit [mgCOD/L]	5.00000	5.00000

### Autotroph

Name	Default	Value
Yield [mgCOD/mgN]	0.24000	0.24000
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in inert [mgP/mgCOD]	0.02200	0.02200
Fraction to endogenous residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

### Heterotroph

Name	Default	Value
Yield (aerobic) [-]	0.66600	0.66600
Yield (fermentation, low H2) [-]	0.10000	0.10000
Yield (fermentation, high H2) [-]	0.10000	0.10000
Yield (fermentation of methanol) [-]	0.10000	0.10000
H2 yield (fermentation low H2) [-]	0.35000	0.35000
H2 yield (fermentation high H2) [-]	0.0	0.0
H2 yield (methanol fermentation) [-]	0.35000	0.35000
Propionate yield (fermentation, low H2) [-]	0.0	0.0
Propionate yield (fermentation, high H2) [-]	0.70000	0.70000
CO2 yield (fermentation, low H2) [-]	0.50000	0.50000
CO2 yield (fermentation, high H2) [-]	0.0	0.0
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in inert [mgP/mgCOD]	0.02200	0.02200
Endogenous Residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
Yield (anoxic) [-]	0.54000	0.54000
Yield propionic (aerobic) [-]	0.50000	0.50000
Yield propionic (anoxic) [-]	0.41000	0.41000
Yield acetic (aerobic) [-]	0.40000	0.40000
Yield acetic (anoxic) [-]	0.32000	0.32000
Yield methanol (aerobic) [-]	0.50000	0.50000
Adsorp. max. [-]	1.00000	1.00000

### Methanol utilizer

Name	Default	Value
Yield (anoxic) [-]	0.40000	0.40000
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in inert [mgP/mgCOD]	0.02200	0.02200
Endogenous Residue [-]	0.08000	0.08000

COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
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### PolyP

Name	Default	Value
Yield (aerobic) [-]	0.63900	0.63900
Yield (anoxic) [-]	0.52000	0.52000
Aerobic P/PHA uptake [mgP/mgCOD]	0.95000	0.95000
Anoxic P/PHA uptake [mgP/mgCOD]	0.35000	0.35000
Yield of PHA on sequestration [-]	0.88900	0.88900
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in part. inert [mgN/mgCOD]	0.07000	0.07000
N in sol. inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in part. inert [mgP/mgCOD]	0.02200	0.02200
Fraction to endogenous part. [-]	0.25000	0.25000
Inert fraction of endogenous sol. [-]	0.20000	0.20000
P/Ac release ratio [mgP/mgCOD]	0.49000	0.49000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
Yield of low PP [-]	0.94000	0.94000

### Propionic Acetogen

Name	Default	Value
Yield [-]	0.10000	0.10000
H <sub>2</sub> yield [-]	0.40000	0.40000
CO <sub>2</sub> yield [-]	1.00000	1.00000
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in endogenous residue [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in endogenous residue [mgP/mgCOD]	0.02200	0.02200
Fraction to endogenous residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

### Methanogen

Name	Default	Value
Acetoclastic yield [-]	0.10000	0.10000
H <sub>2</sub> -utilizing yield [-]	0.10000	0.10000
N in acetoclastic biomass [mgN/mgCOD]	0.07000	0.07000
N in H <sub>2</sub> -utilizing biomass [mgN/mgCOD]	0.07000	0.07000
N in acetoclastic endog. residue [mgN/mgCOD]	0.07000	0.07000
N in H <sub>2</sub> -utilizing endog. residue [mgN/mgCOD]	0.07000	0.07000
P in acetoclastic biomass [mgP/mgCOD]	0.02200	0.02200
P in H <sub>2</sub> -utilizing biomass [mgP/mgCOD]	0.02200	0.02200
P in acetoclastic endog. residue [mgP/mgCOD]	0.02200	0.02200
P in H <sub>2</sub> -utilizing endog. residue [mgP/mgCOD]	0.02200	0.02200
Acetoclastic fraction to endog. residue [-]	0.08000	0.08000
H <sub>2</sub> -utilizing fraction to endog. residue [-]	0.08000	0.08000
Acetoclastic COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
H <sub>2</sub> -utilizing COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

### General

Name	Default	Value
Particulate substrate COD:VSS ratio [mgCOD/mgVSS]	1.60000	1.60000
Particulate inert COD:VSS ratio [mgCOD/mgVSS]	1.60000	1.60000
Ash content of biomass (synthesis ISS) [%]	8.00000	8.00000
Molecular weight of other anions [mg/mmol]	35.50000	35.50000
Molecular weight of other cations [mg/mmol]	39.10000	39.10000
Mg to P mole ratio in polyphosphate [mmolMg/mmolP]	0.30000	0.30000
Cation to P mole ratio in polyphosphate [meq/mmolP]	0.30000	0.30000
Ca to P mole ratio in polyphosphate [mmolCa/mmolP]	0.05000	0.05000
Cation to P mole ratio in organic phosphate [meq/mmolP]	0.01000	0.01000
Bubble rise velocity (anaerobic digester) [cm/s]	23.90000	23.90000
Bubble Sauter mean diameter (anaerobic digester) [cm]	0.35000	0.35000

## Mass transfer

Name	Default	Value	
K1 for H2 [m/d]	17.00000	17.00000	1.0000
K1 for CO2 [m/d]	10.00000	10.00000	1.0000
K1 for NH3 [m/d]	1.00000	1.00000	1.0000

## Physico-chemical rates

Name	Default	Value	
Struvite precipitation rate [1/d]	3.0000E+10	3.0000E+10	1.0240
Struvite redissolution rate [1/d]	3.0000E+11	3.0000E+11	1.0240
Struvite half sat. [mgTSS/L]	1.00000	1.00000	1.0000
HDP precipitation rate [L/(mol P d)]	1.0000E+8	1.0000E+8	1.0000
HDP redissolution rate [L/(mol P d)]	1.0000E+8	1.0000E+8	1.0000
HAP precipitation rate [molHDP/(L d)]	5.0000E-4	5.0000E-4	1.0000

## Physico-chemical constants

Name	Default	Value
Struvite solubility constant [mol/L]	6.9180E-14	6.9180E-14
HDP solubility product [mol/L]	2.7500E-22	2.7500E-22
HDP half sat. [mgTSS/L]	1.00000	1.00000
Equilibrium soluble PO4 with Al dosing at pH 7 [mgP/L]	0.01000	0.01000
Al to P ratio [molAl/molP]	0.80000	0.80000
Al(OH)3 solubility product [mol/L]	1.2590E+9	1.2590E+9
AlHPO4+ dissociation constant [mol/L]	7.9430E-13	7.9430E-13
Equilibrium soluble PO4 with Fe dosing at pH 7 [mgP/L]	0.01000	0.01000
Fe to P ratio [molFe/molP]	1.60000	1.60000
Fe(OH)3 solubility product [mol/L]	0.05000	0.05000
FeH2PO4++ dissociation constant [mol/L]	5.0120E-22	5.0120E-22

## Aeration

Name	Default	Value
Alpha (surf) OR Alpha F (diff) [-]	0.50000	0.50000
Beta [-]	0.95000	0.95000
Surface pressure [kPa]	101.32500	101.32500
Fractional effective saturation depth (Fed) [-]	0.32500	0.32500
Supply gas CO2 content [vol. %]	0.03500	0.03500
Supply gas O2 [vol. %]	20.95000	20.95000
Off-gas CO2 [vol. %]	2.00000	2.00000
Off-gas O2 [vol. %]	18.80000	18.80000
Off-gas H2 [vol. %]	0.0	0.0
Off-gas NH3 [vol. %]	0.0	0.0
Surface turbulence factor [-]	0.25000	0.25000
Set point controller gain []	1.00000	1.00000

## Modified Vesilind

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [f/min]	0.3873	0.3873
Vesilind hindered zone settling parameter (K) [L/g]	0.3700	0.3700
Clarification switching function [mg/L]	100.0000	100.0000
Specified TSS conc. for height calc. [mg/L]	2500.0000	2500.0000
Maximum compactability constant [mg/L]	15000.0000	15000.0000

## Double exponential

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [f/min]	0.9341	0.9341
Maximum (practical) settling velocity (Vo') [f/min]	0.6152	0.6152
Hindered zone settling parameter (Kh) [L/g]	0.4000	0.4000
Flocculent zone settling parameter (Kf) [L/g]	2.5000	2.5000
Maximum non-settleable TSS [mg/L]	20.0000	20.0000
Non-settleable fraction [-]	0.0010	0.0010
Specified TSS conc. for height calc. [mg/L]	2500.0000	2500.0000



## **APPENDIX F**

### **BioWin Model Results for Future Conditions at Step Feed Operation**

## BioWin user and configuration data

### Project details

Project name: Future Conditions - Step Feed

Plant name: Kingston

Project ref.: 5744001

User name: MARPICATI

Created: 5/23/2006

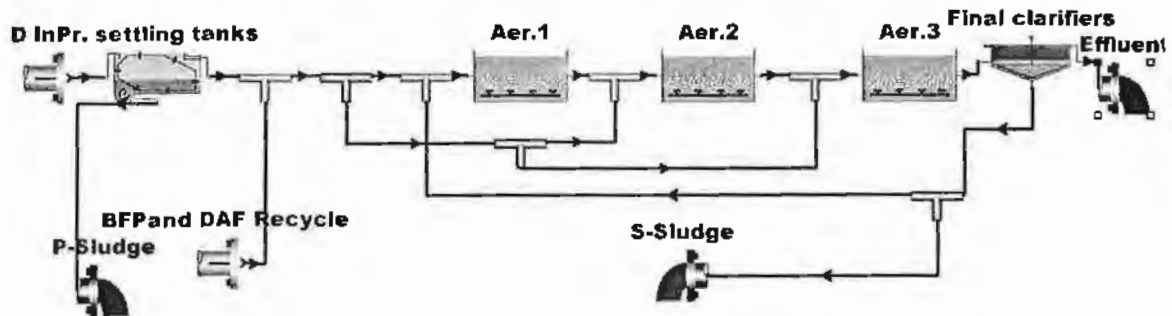
Saved: 8/12/2008

### Steady state solution

SRT: 3.65

Temperature: 20.0

### Flowsheet



## Configuration information for all Ideal primary settling tank units

### Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Pr. settling tanks	0.4625	5472.0000	11.3

### Operating data Average (flow/time weighted as required)

Element name	Split type	Average Split specification
Pr. settling tanks	Flowrate [Under]	0.18

Element name	Percent removal	Blanket fraction
Pr. settling tanks	60.00	0.10

## Configuration information for all Bioreactor units

### Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]	# of diffusers
Aer.1	0.3936	3330.0000	15.8	755
Aer.2	0.3936	3330.0000	15.8	755
Aer.3	0.3936	3330.0000	15.8	755

### Operating data Average (flow/time weighted as required)

Element name	Average DO Setpoint
Aer.1	2.0
Aer.2	2.0
Aer.3	2.0

### Aeration equipment parameters

Element name	$k_1$ in C = $k_1(PC)^{0.25} + k_2$	$k_2$ in C = $k_1(PC)^{0.25} + k_2$	Y in $Kla = C Usg \wedge$ Y - Usg in [m <sup>3</sup> /(m <sup>2</sup> d)]	Area of one diffuser	% of tank area covered by diffusers [%]
Aer.1	2.5656	0.0432	0.8200	0.0410	10.0000
Aer.2	2.5656	0.0432	0.8200	0.0410	10.0000
Aer.3	2.5656	0.0432	0.8200	0.0410	10.0000

### Configuration information for all Sidestream Mixer units

#### Physical data

Element name	Volume[Mil. Gal]	Area[ft <sup>2</sup> ]	Depth[ft]
Sidestream Mixer10	0	N/A	N/A
Sidestream Mixer30	0	N/A	N/A
Sidestream Mixer32	0	N/A	N/A
Sidestream Mixer7	0	N/A	N/A

### Configuration information for all Splitter units

#### Physical data

Element name	Volume[Mil. Gal]	Area[ft <sup>2</sup> ]	Depth[ft]
Splitter4	0	N/A	N/A
Splitter20	0	N/A	N/A
Splitter23	0	N/A	N/A

### Operating data Average (flow/time weighted as required)

Element name	Split type	Average Split specification
Splitter4	Flowrate [Side]	0.065
Splitter20	Ratio	2.00
Splitter23	Ratio	1.00

### Configuration information for all BOD Influent units

### Operating data Average (flow/time weighted as required)

Element name	BOD Influent	BFPand DAF Recycle
Flow	6.4036	0.343
Total Carbonaceous BOD mg/L	138.98	172.00
Volatile suspended solids mg/L	123.84	119.50
Total suspended solids mgTSS/L	165.13	447.10
Total Kjeldahl Nitrogen mgN/L	22.08	136.00
Total P mgP/L	13.70	10.00
Nitrate N mgN/L	0.00	0.00
pH	7.60	7.30
Alkalinity mmol/L	1.33	12.00
Calcium mg/L	160.00	160.00
Magnesium mg/L	25.00	25.00
Dissolved oxygen mg/L	0.00	0.00

Element name	BOD Influent	BFPand DAF Recycle
Fbs - Readily biodegradable (including Acetate) [gCOD/g of total COD]	0.2000	0.2000
Fac - Acetate [gCOD/g of readily biodegradable COD]	0.1500	0.1500
Fxsp - Non-colloidal slowly biodegradable [gCOD/g of slowly degradable COD]	0.8951	0.6916
Fus - Unbiodegradable soluble [gCOD/g of total COD]	0.0500	0.0500
Fup - Unbiodegradable particulate [gCOD/g of total COD]	0.1300	0.1300
Fna - Ammonia [gNH3-N/gTKN]	0.7500	0.6600
Fnox - Particulate organic nitrogen [gN/g Organic N]	0.5000	0.5000
Fnus - Soluble unbiodegradable TKN [gN/gTKN]	0.0000	0.0000
FupN - N:COD ratio for unbiodegradable part. COD [gN/gCOD]	0.0350	0.0350
Fpo4 - Phosphate [gPO4-P/gTP]	0.5000	0.5000
FupP - P:COD ratio for influent unbiodegradable part. COD [gP/gCOD]	0.0110	0.0110
FZbh - Non-poly-P heterotrophs [gCOD/g of total COD]	0.0001	0.0001
FZbm - Anoxic methanol utilizers [gCOD/g of total COD]	0.0001	0.0001
FZba - Autotrophs [gCOD/g of total COD]	0.0001	0.0001
FZbp - PAOs [gCOD/g of total COD]	0.0001	0.0001
FZbpa - Propionic acetogens [gCOD/g of total COD]	0.0001	0.0001
FZbam - Acetoclastic methanogens [gCOD/g of total COD]	0.0001	0.0001
FZbhm - H2-utilizing methanogens [gCOD/g of total COD]	0.0001	0.0001

## Configuration information for all Ideal clarifier units

### Physical data

Element name	Volume [Mil. Gal]	Area [ft2]	Depth [ft]
Final clarifiers	0.7109	8640.0000	11.0

### Operating data Average (flow/time weighted as required)

Element name	Split type	Average Split specification
Final clarifiers	Flowrate [Under]	3596.14

Element name	Average Temperature	Reactive	Percent removal	Blanket fraction
Final clarifiers	Uses global setting	No	98.40	0.05

## Configuration information for all Effluent units

## Configuration information for all Sludge units

### BioWin Album

#### Album page - Effluent

Effluent			
Parameters	Conc. (mg/L)	Mass rate (lb/d)	Notes
Volatile suspended solids	11.32	614.41	
Total suspended solids	18.53	1005.17	
Particulate COD	16.55	897.82	
Filtered COD	17.59	954.45	
Total COD	34.14	1852.27	
Soluble PO4-P	7.97	432.70	
Total P	8.31	450.71	
Filtered TKN	11.38	617.23	
Particulate TKN	1.02	55.33	
Total Kjeldahl Nitrogen	12.40	672.57	
Filtered Carbonaceous BOD	2.11	114.64	
Total Carbonaceous BOD	8.63	468.45	
Total N	21.30	1155.86	
Total inorganic N	18.67	1013.23	

Alkalinity	0.51	12.63	mmol/L and kmol/d
pH	6.01		
Volatile fatty acids	0.05	2.93	
Total precipitated solids	0.00	0.00	
Total inorganic suspended solids	7.20	390.76	
Ammonia N	9.77	529.93	
Nitrate N	8.91	483.30	
Parameters	Value	Units	
pH	6.01		
Ionized ammonium	9.76	mgN/L	
Unionized ammonia	0.00	mgN/L	
Total dissolved CO2	1.01	mmol/L	
Bicarbonate	0.49	mmol/L	
Carbonate	0.00	mmol/L	
Unionized ortho-P	0.00	mgP/L	
H2PO4-	7.28	mgP/L	
HPO4--	0.69	mgP/L	
PO4---	0.00	mgP/L	
Metal phosphate (solid)	0.00	mgTSS/L	
Metal hydroxide (solid)	0.00	mgTSS/L	
Metal ion	0.00	mgMe/L	
MeH2PO4++	0.00	mgMe/L	
MeHPO4+	0.00	mgMe/L	
Acetic acid	0.00	mg/L	
Acetate	0.05	mg/L	
Propionic acid	0.00	mg/L	
Propionate	0.00	mg/L	
Ionic strength	0.02		
Flow	6.50	mgd	

### Album page - Aer.1

Aer.1			
Parameters	Conc. (mg/L)	Mass rate (lb/d)	Notes
Volatile suspended solids	1403.75	36010.03	
Total suspended solids	2303.26	59084.79	
Particulate COD	2049.15	52566.21	
Filtered COD	16.62	426.38	
Total COD	2065.77	52992.58	
Soluble PO4-P	8.51	218.40	
Total P	49.42	1267.76	
Filtered TKN	9.49	243.47	
Particulate TKN	127.14	3261.50	
Total Kjeldahl Nitrogen	136.63	3504.97	
Filtered Carbonaceous BOD	1.43	36.63	
Total Carbonaceous BOD	805.37	20659.89	
Total N	147.48	3783.23	
Total inorganic N	18.88	484.42	
Alkalinity	0.23	2.72	mmol/L and kmol/d
pH	5.65		
Volatile fatty acids	0.02	0.61	
Total precipitated solids	0.00	0.00	
Total inorganic suspended solids	899.51	23074.76	
Ammonia N	8.04	206.16	
Nitrate N	10.85	278.26	
Parameters	Value	Units	
Hydraulic residence time	3.1	hours	
Flow	3.07	mgd	
MLSS	2303.26	mg/L	
Dissolved oxygen	2.00	mg/L	
Total readily biodegradable COD	1.90	mg/L	
Total oxygen uptake rate	36.61	mgO/L/hr	
Carbonaceous OUR	24.17	mgO/L/hr	
Nitrogenous OUR	12.44	mgO/L/hr	
Nitrate uptake rate	0.18	mgN/L/hr	

Nitrification rate	2.87	mgN/L/hr
Denitrification rate	0.18	mgN/L/hr
Spec. denite rate per VSS	0.13	mgN/g VSS/hr
Spec. denite rate per VASS	0.18	mgN/g VASS/hr
Net Nitrate production rate	2.70	mgN/L/hr
OTE	11.26	%
OTR	121.77	lb/hr
SOTE	34.91	%
SOTR	368.99	lb/hr
Air supply rate	1035.83	ft <sup>3</sup> /min (20C, 1 atm)
Air flow rate / diffuser	1.37	ft <sup>3</sup> /min (20C, 1 atm)
# of diffusers	755.00	
Off gas flow rate (dry)	1030.06	ft <sup>3</sup> /min
Oxygen content	18.77	%
Carbon dioxide content	1.84	%
Ammonia content	0.00	%
Actual DO sat. conc.	8.86	mg/L

## Album page - Aer.2

Aer.2			
Parameters	Conc. (mg/L)	Mass rate (lb/d)	Notes
Volatile suspended solids	845.80	37147.04	
Total suspended solids	1386.55	60896.91	
Particulate COD	1235.08	54244.13	
Filtered COD	17.05	748.95	
Total COD	1252.13	54993.08	
Soluble PO4-P	8.20	360.09	
Total P	32.89	1444.70	
Filtered TKN	10.48	460.29	
Particulate TKN	76.46	3357.95	
Total Kjeldahl Nitrogen	86.94	3818.24	
Filtered Carbonaceous BOD	1.73	76.10	
Total Carbonaceous BOD	486.90	21384.39	
Total N	96.78	4250.69	
Total inorganic N	18.79	825.41	
Alkalinity	0.38	7.58	mmol/L and kmol/d
pH	5.87		
Volatile fatty acids	0.04	1.73	
Total precipitated solids	0.00	0.00	
Total inorganic suspended solids	540.76	23749.87	
Ammonia N	8.95	392.96	
Nitrate N	9.85	432.45	
Parameters	Value	Units	
Hydraulic residence time	1.8	hours	
Flow	5.26	mgd	
MLSS	1386.55	mg/L	
Dissolved oxygen	2.00	mg/L	
Total readily biodegradable COD	2.24	mg/L	
Total oxygen uptake rate	25.83	mgO/L/hr	
Carbonaceous OUR	16.82	mgO/L/hr	
Nitrogenous OUR	9.00	mgO/L/hr	
Nitrate uptake rate	0.12	mgN/L/hr	
Nitrification rate	2.08	mgN/L/hr	
Denitrification rate	0.12	mgN/L/hr	
Spec. denite rate per VSS	0.14	mgN/g VSS/hr	
Spec. denite rate per VASS	0.21	mgN/g VASS/hr	
Net Nitrate production rate	1.96	mgN/L/hr	
OTE	12.14	%	
OTR	86.35	lb/hr	
SOTE	37.65	%	
SOTR	261.68	lb/hr	
Air supply rate	681.19	ft <sup>3</sup> /min (20C, 1 atm)	
Air flow rate / diffuser	0.90	ft <sup>3</sup> /min (20C, 1 atm)	
# of diffusers	755.00		
Off gas flow rate (dry)	675.83	ft <sup>3</sup> /min	
Oxygen content	18.66	%	

Carbon dioxide content	1.80	%
Ammonia content	0.00	%
Actual DO sat. conc.	8.86	mg/L

### Album page - Aer.3

Aer.3			
Parameters	Conc. (mg/L)	Mass rate (lb/d)	Notes
Volatile suspended solids	617.51	38400.62	
Total suspended solids	1010.23	62823.00	
Particulate COD	902.35	56113.96	
Filtered COD	17.59	1093.91	
Total COD	919.94	57207.87	
Soluble PO4-P	7.97	495.93	
Total P	26.08	1621.64	
Filtered TKN	11.38	707.42	
Particulate TKN	55.61	3458.41	
Total Kjeldahl Nitrogen	66.99	4165.83	
Filtered Carbonaceous BOD	2.11	131.39	
Total Carbonaceous BOD	357.71	22244.54	
Total N	75.90	4719.74	
Total inorganic N	18.67	1161.28	
Alkalinity	0.51	14.48	mmol/L and kmol/d
pH	6.01		
Volatile fatty acids	0.05	3.36	
Total precipitated solids	0.00	0.00	
Total inorganic suspended solids	392.73	24422.39	
Ammonia N	9.77	607.37	
Nitrate N	8.91	553.91	
Parameters	Value	Units	
Hydraulic residence time	1.3	hours	
Flow	7.45	mgd	
MLSS	1010.23	mg/L	
Dissolved oxygen	2.00	mg/L	
Total readily biodegradable COD	2.70	mg/L	
Total oxygen uptake rate	21.18	mgO/L/hr	
Carbonaceous OUR	14.06	mgO/L/hr	
Nitrogenous OUR	7.12	mgO/L/hr	
Nitrate uptake rate	0.10	mgN/L/hr	
Nitrification rate	1.64	mgN/L/hr	
Denitrification rate	0.10	mgN/L/hr	
Spec. denite rate per VSS	0.16	mgN/gVSS/hr	
Spec. denite rate per VASS	0.24	mgN/gVASS/hr	
Net Nitrate production rate	1.54	mgN/L/hr	
OTE	12.67	%	
OTR	71.07	lb/hr	
SOTE	39.29	%	
SOTR	215.38	lb/hr	
Air supply rate	537.21	ft <sup>3</sup> /min (20C, 1 atm)	
Air flow rate / diffuser	0.71	ft <sup>3</sup> /min (20C, 1 atm)	
# of diffusers	755.00		
Off gas flow rate (dry)	532.05	ft <sup>3</sup> /min	
Oxygen content	18.61	%	
Carbon dioxide content	1.74	%	
Ammonia content	0.00	%	
Actual DO sat. conc.	8.86	mg/L	

### Global Parameters

#### Autotroph

Name	Default	Value	
Max. spec. growth rate [1/d]	0.90000	0.90000	1.0720
Substrate (NH4) half sat. [mgN/L]	0.70000	0.70000	1.0000
Aerobic decay rate [1/d]	0.17000	0.17000	1.0290

Anoxic/anaerobic decay rate [1/d]	0.08000	0.08000	1.0290
CO2 half sat. for autotrophs [mmol/L]	0.01000	0.01000	1.0000

## Heterotroph

Name	Default	Value	
Max. spec. growth rate [1/d]	3.20000	3.20000	1.0290
Substrate half sat. [mgCOD/L]	5.00000	5.00000	1.0000
Anoxic growth factor [-]	0.50000	0.50000	1.0000
Aerobic decay [1/d]	0.62000	0.62000	1.0290
Anoxic/anaerobic decay [1/d]	0.30000	0.30000	1.0290
Hydrolysis rate (AS) [1/d]	2.10000	2.10000	1.0290
Hydrolysis half sat. (AS) [-]	0.06000	0.06000	1.0000
Anoxic hydrolysis factor [-]	0.28000	0.28000	1.0000
Anaerobic hydrolysis factor [-]	0.50000	0.50000	1.0000
Adsorption rate of colloids [L/(mgCOD d)]	0.80000	0.80000	1.0290
Ammonification rate [L/(mgN d)]	0.04000	0.04000	1.0290
Fermentation rate [1/d]	3.20000	3.20000	1.0290
Fermentation half sat. [mgCOD/L]	5.00000	5.00000	1.0000
Anaerobic growth factor (AS) [-]	0.12500	0.12500	1.0000
Hydrolysis rate (AD) [1/d]	0.10000	0.10000	1.0500
Hydrolysis half sat. (AD) [mgCOD/L]	0.15000	0.15000	1.0000

## Methanol utilizers

Name	Default	Value	
Max. spec. growth rate of methanol utilizers [1/d]	6.40000	6.40000	1.0290
Methanol half sat. [mgCOD/L]	0.50000	0.50000	1.0000
Aerobic decay rate of methanol utilizers [1/d]	0.24000	0.24000	1.0290
Anoxic/anaerobic decay rate of methanol utilizers [1/d]	0.12000	0.12000	1.0290

## PolyP

Name	Default	Value	
Max. spec. growth rate [1/d]	0.95000	0.95000	1.0000
Max. spec. growth rate, P-limited [1/d]	0.42000	0.42000	1.0000
Substrate half sat. [mgCOD/L]	0.10000	0.10000	1.0000
Substrate half sat., P-limited [mgCOD/L]	0.05000	0.05000	1.0000
Magnesium half sat. [mgMg/L]	0.10000	0.10000	1.0000
Cation half sat. [mmol/L]	0.10000	0.10000	1.0000
Calcium half sat. [mgCa/L]	0.10000	0.10000	1.0000
Aerobic decay rate [1/d]	0.10000	0.10000	1.0000
Anaerobic decay rate [1/d]	0.04000	0.04000	1.0000
Sequestration rate [1/d]	6.00000	6.00000	1.0000
Anoxic growth factor [-]	0.33000	0.33000	1.0000

## Propionic Acetogen

Name	Default	Value	
Max. spec. growth rate [1/d]	0.25000	0.25000	1.0290
Substrate half sat. [mgCOD/L]	10.00000	10.00000	1.0000
Acetate inhibition [mgCOD/L]	10000.00000	10000.00000	1.0000
Decay rate [1/d]	0.05000	0.05000	1.0290
Aerobic decay rate [1/d]	0.52000	0.52000	1.0290

## Methanogen

Name	Default	Value	
Acetoclastic Mu Max [1/d]	0.30000	0.30000	1.0290
H2-utilizing Mu Max [1/d]	1.40000	1.40000	1.0290
Acetoclastic Ks [mgCOD/L]	100.00000	100.00000	1.0000
H2-utilizing CO2 half sat. [mmol/L]	0.10000	0.10000	1.0000
H2-utilizing Ks [mgCOD/L]	0.10000	0.10000	1.0000
Acetoclastic propionic inhibition [mgCOD/L]	10000.00000	10000.00000	1.0000
Acetoclastic decay rate [1/d]	0.13000	0.13000	1.0290
Acetoclastic aerobic decay rate [1/d]	0.60000	0.60000	1.0290
H2-utilizing decay rate [1/d]	0.13000	0.13000	1.0290
H2-utilizing aerobic decay rate [1/d]	0.60000	0.60000	1.0290

## pH Inhibition

Name	Default	Value
Heterotrophs low pH limit [-]	4.00000	4.00000
Heterotrophs high pH limit [-]	10.00000	10.00000
Methanol utilizers low pH limit [-]	4.00000	4.00000
Methanol utilizers high pH limit [-]	10.00000	10.00000
Autotrophs low pH limit [-]	5.50000	5.50000
Autotrophs high pH limit [-]	9.50000	9.50000
PolyP heterotrophs low pH limit [-]	4.00000	4.00000
Poly P heterotrophs high pH limit [-]	10.00000	10.00000
Heterotrophs low pH limit (anaerobic) [-]	5.50000	5.50000
Heterotrophs high pH limit (anaerobic) [-]	8.50000	8.50000
Propionic acetogens low pH limit [-]	4.00000	4.00000
Propionic acetogens high pH limit [-]	10.00000	10.00000
Acetoclastic methanogens low pH limit [-]	5.50000	5.50000
Acetoclastic methanogens high pH limit [-]	8.50000	8.50000
H <sub>2</sub> -utilizing methanogens low pH limit [-]	5.50000	5.50000
H <sub>2</sub> -utilizing methanogens high pH limit [-]	8.50000	8.50000

## Switching Functions

Name	Default	Value
Heterotrophic DO limit [mgO <sub>2</sub> /L]	0.05000	0.05000
Aerobic denit. DO limit [mgO <sub>2</sub> /L]	0.05000	0.05000
Autotrophic DO limit [mgO <sub>2</sub> /L]	0.25000	0.25000
Anoxic NO <sub>3</sub> limit [mgN/L]	0.10000	0.10000
NH <sub>3</sub> nutrient limit [mgN/L]	0.00500	0.00500
NO <sub>3</sub> nutrient limit [mgN/L]	0.00500	0.00500
PolyP limit [mgP/L]	0.01000	0.01000
VFA sequestration limit [mgCOD/L]	5.00000	5.00000
P uptake limit [mgP/L]	0.15000	0.15000
P nutrient limit [mgP/L]	0.00500	0.00500
Heterotrophic Hydrogen limit [mgCOD/L]	1.00000	1.00000
Propionic acetogens Hydrogen limit [mgCOD/L]	5.00000	5.00000

## Autotroph

Name	Default	Value
Yield [mgCOD/mgN]	0.24000	0.24000
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in inert [mgP/mgCOD]	0.02200	0.02200
Fraction to endogenous residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

## Heterotroph

Name	Default	Value
Yield (aerobic) [-]	0.66600	0.66600
Yield (fermentation, low H <sub>2</sub> ) [-]	0.10000	0.10000
Yield (fermentation, high H <sub>2</sub> ) [-]	0.10000	0.10000
Yield (fermentation of methanol) [-]	0.10000	0.10000
H <sub>2</sub> yield (fermentation low H <sub>2</sub> ) [-]	0.35000	0.35000
H <sub>2</sub> yield (fermentation high H <sub>2</sub> ) [-]	0.0	0.0
H <sub>2</sub> yield (methanol fermentation) [-]	0.35000	0.35000
Propionate yield (fermentation, low H <sub>2</sub> ) [-]	0.0	0.0
Propionate yield (fermentation, high H <sub>2</sub> ) [-]	0.70000	0.70000
CO <sub>2</sub> yield (fermentation, low H <sub>2</sub> ) [-]	0.50000	0.50000
CO <sub>2</sub> yield (fermentation, high H <sub>2</sub> ) [-]	0.0	0.0
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in inert [mgP/mgCOD]	0.02200	0.02200
Endogenous Residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
Yield (anoxic) [-]	0.54000	0.54000
Yield propionic (aerobic) [-]	0.50000	0.50000

Yield propionic (anoxic) [-]	0.41000	0.41000
Yield acetic (aerobic) [-]	0.40000	0.40000
Yield acetic (anoxic) [-]	0.32000	0.32000
Yield methanol (aerobic) [-]	0.50000	0.50000
Adsorp. max. [-]	1.00000	1.00000

### Methanol utilizer

Name	Default	Value
Yield (anoxic) [-]	0.40000	0.40000
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in inert [mgP/mgCOD]	0.02200	0.02200
Endogenous Residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

### PolyP

Name	Default	Value
Yield (aerobic) [-]	0.63900	0.63900
Yield (anoxic) [-]	0.52000	0.52000
Aerobic P/PHA uptake [mgP/mgCOD]	0.95000	0.95000
Anoxic P/PHA uptake [mgP/mgCOD]	0.35000	0.35000
Yield of PHA on sequestration [-]	0.88900	0.88900
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in part. inert [mgN/mgCOD]	0.07000	0.07000
N in sol. inert [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in part. inert [mgP/mgCOD]	0.02200	0.02200
Fraction to endogenous part. [-]	0.25000	0.25000
Inert fraction of endogenous sol. [-]	0.20000	0.20000
P/Ac release ratio [mgP/mgCOD]	0.49000	0.49000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
Yield of low PP [-]	0.94000	0.94000

### Propionic Acetogen

Name	Default	Value
Yield [-]	0.10000	0.10000
H <sub>2</sub> yield [-]	0.40000	0.40000
CO <sub>2</sub> yield [-]	1.00000	1.00000
N in biomass [mgN/mgCOD]	0.07000	0.07000
N in endogenous residue [mgN/mgCOD]	0.07000	0.07000
P in biomass [mgP/mgCOD]	0.02200	0.02200
P in endogenous residue [mgP/mgCOD]	0.02200	0.02200
Fraction to endogenous residue [-]	0.08000	0.08000
COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

### Methanogen

Name	Default	Value
Acetoclastic yield [-]	0.10000	0.10000
H <sub>2</sub> -utilizing yield [-]	0.10000	0.10000
N in acetoclastic biomass [mgN/mgCOD]	0.07000	0.07000
N in H <sub>2</sub> -utilizing biomass [mgN/mgCOD]	0.07000	0.07000
N in acetoclastic endog. residue [mgN/mgCOD]	0.07000	0.07000
N in H <sub>2</sub> -utilizing endog. residue [mgN/mgCOD]	0.07000	0.07000
P in acetoclastic biomass [mgP/mgCOD]	0.02200	0.02200
P in H <sub>2</sub> -utilizing biomass [mgP/mgCOD]	0.02200	0.02200
P in acetoclastic endog. residue [mgP/mgCOD]	0.02200	0.02200
P in H <sub>2</sub> -utilizing endog. residue [mgP/mgCOD]	0.02200	0.02200
Acetoclastic fraction to endog. residue [-]	0.08000	0.08000
H <sub>2</sub> -utilizing fraction to endog. residue [-]	0.08000	0.08000
Acetoclastic COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000
H <sub>2</sub> -utilizing COD:VSS ratio [mgCOD/mgVSS]	1.42000	1.42000

## General

Name	Default	Value
Particulate substrate COD:VSS ratio [mgCOD/mgVSS]	1.60000	1.60000
Particulate inert COD:VSS ratio [mgCOD/mgVSS]	1.60000	1.60000
Ash content of biomass (synthesis ISS) [%]	8.00000	8.00000
Molecular weight of other anions [mg/mmol]	35.50000	35.50000
Molecular weight of other cations [mg/mmol]	39.10000	39.10000
Mg to P mole ratio in polyphosphate [mmolMg/mmolP]	0.30000	0.30000
Cation to P mole ratio in polyphosphate [meq/mmolP]	0.30000	0.30000
Ca to P mole ratio in polyphosphate [mmolCa/mmolP]	0.05000	0.05000
Cation to P mole ratio in organic phosphate [meq/mmolP]	0.01000	0.01000
Bubble rise velocity (anaerobic digester) [cm/s]	23.90000	23.90000
Bubble Sauter mean diameter (anaerobic digester) [cm]	0.35000	0.35000

## Mass transfer

Name	Default	Value
K1 for H2 [m/d]	17.00000	17.00000
K1 for CO2 [m/d]	10.00000	10.00000
K1 for NH3 [m/d]	1.00000	1.00000

## Physico-chemical rates

Name	Default	Value
Struvite precipitation rate [1/d]	3.0000E+10	3.0000E+10
Struvite redissolution rate [1/d]	3.0000E+11	3.0000E+11
Struvite half sat. [mgTSS/L]	1.00000	1.00000
HDP precipitation rate [L/(molP d)]	1.0000E+8	1.0000E+8
HDP redissolution rate [L/(mol P d)]	1.0000E+8	1.0000E+8
HAP precipitation rate [molHDP/(L d)]	5.0000E-4	5.0000E-4

## Physico-chemical constants

Name	Default	Value
Struvite solubility constant [mol/L]	6.9180E-14	6.9180E-14
HDP solubility product [mol/L]	2.7500E-22	2.7500E-22
HDP half sat. [mgTSS/L]	1.00000	1.00000
Equilibrium soluble PO4 with Al dosing at pH 7 [mgP/L]	0.01000	0.01000
Al to P ratio [molAl/molP]	0.80000	0.80000
Al(OH)3 solubility product [mol/L]	1.2590E+9	1.2590E+9
AlHPO4+ dissociation constant [mol/L]	7.9430E-13	7.9430E-13
Equilibrium soluble PO4 with Fe dosing at pH 7 [mgP/L]	0.01000	0.01000
Fe to P ratio [molFe/molP]	1.60000	1.60000
Fe(OH)3 solubility product [mol/L]	0.05000	0.05000
FeH2PO4++ dissociation constant [mol/L]	5.0120E-22	5.0120E-22

## Aeration

Name	Default	Value
Alpha (surf) OR Alpha F (diff) [-]	0.50000	0.50000
Beta [-]	0.95000	0.95000
Surface pressure [kPa]	101.32500	101.32500
Fractional effective saturation depth (Fed) [-]	0.32500	0.32500
Supply gas CO2 content [vol. %]	0.03500	0.03500
Supply gas O2 [vol. %]	20.95000	20.95000
Off-gas CO2 [vol. %]	2.00000	2.00000
Off-gas O2 [vol. %]	18.80000	18.80000
Off-gas H2 [vol. %]	0.0	0.0
Off-gas NH3 [vol. %]	0.0	0.0
Surface turbulence factor [-]	0.25000	0.25000
Set point controller gain []	1.00000	1.00000

### Modified Vesilind

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [ft/min]	0.3873	0.3873
Vesilind hindered zone settling parameter (K) [L/g]	0.3700	0.3700
Clarification switching function [mg/L]	100.0000	100.0000
Specified TSS conc. for height calc. [mg/L]	2500.0000	2500.0000
Maximum compactability constant [mg/L]	15000.0000	15000.0000

### Double exponential

Name	Default	Value
Maximum Vesilind settling velocity (Vo) [ft/min]	0.9341	0.9341
Maximum (practical) settling velocity (Vo') [ft/min]	0.6152	0.6152
Hindered zone settling parameter (Kh) [L/g]	0.4000	0.4000
Flocculent zone settling parameter (Kf) [L/g]	2.5000	2.5000
Maximum non-settleable TSS [mg/L]	20.0000	20.0000
Non-settleable fraction [-]	0.0010	0.0010
Specified TSS conc. for height calc. [mg/L]	2500.0000	2500.0000